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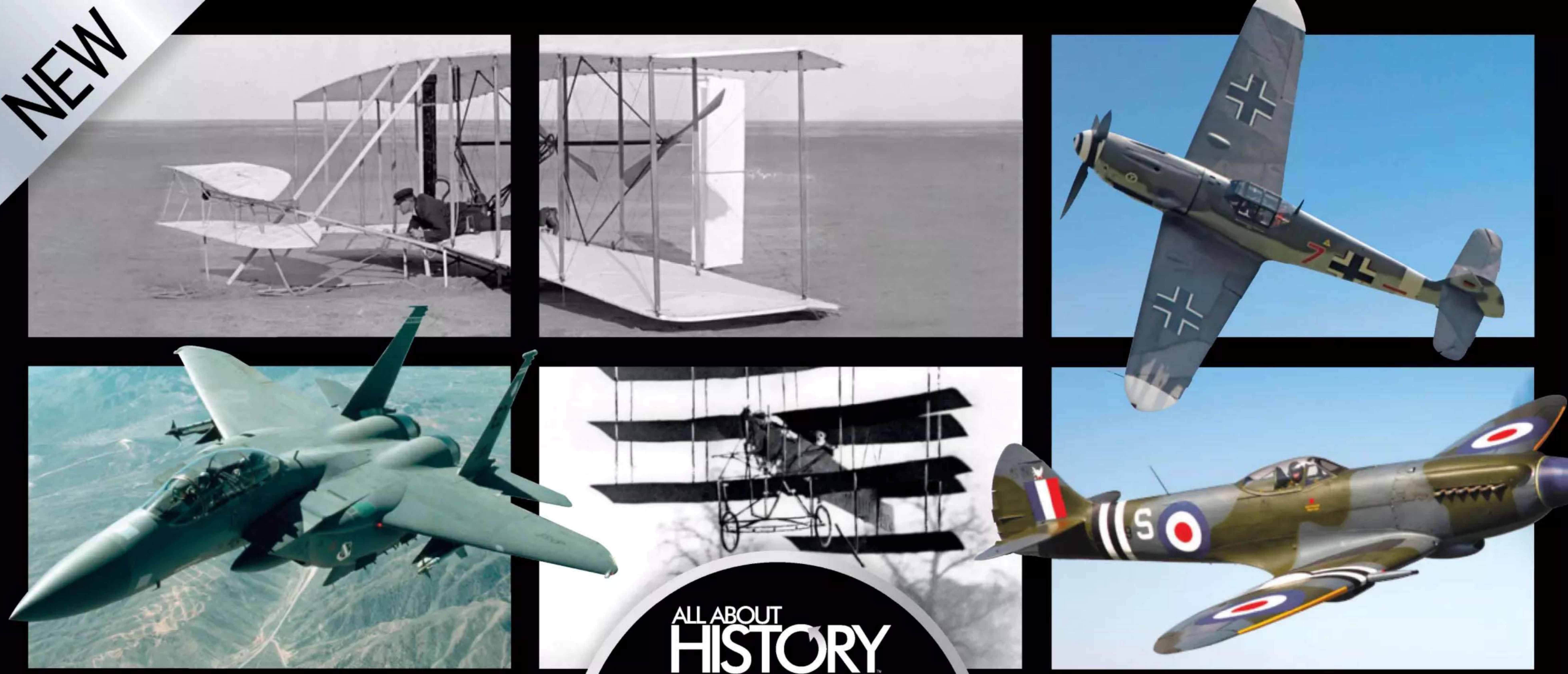

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OVER 200 YEARS OF HISTORY

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Manned heavier-than-air flight was undoubtedly one of the most important achievements of the 20th century, playing a crucial role in shaping the modern world that we know today. As tools for travel, aircraft have brought people together. As tools of war, they have all too frequently torn people apart. The story of flight is a global one. From Kitty Hawk, North Carolina, the site of the first flights by the Wright brothers, through to modern day Afghanistan and Iraq where aircraft have been at the forefront of conflict, our journey takes us across every continent of the world, into the skies above deserts, oceans and beyond, in times of peace and war. As much about people as it is about technology, this is a story of passengers and pilots, entrepreneurs and adventurers, involving both high drama and terrible human tragedy.

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ALL ABOUT HISTORY

Book of

FLIGHT

THE EVOLUTION OF AVIATION

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ALL ABOUT HISTORY
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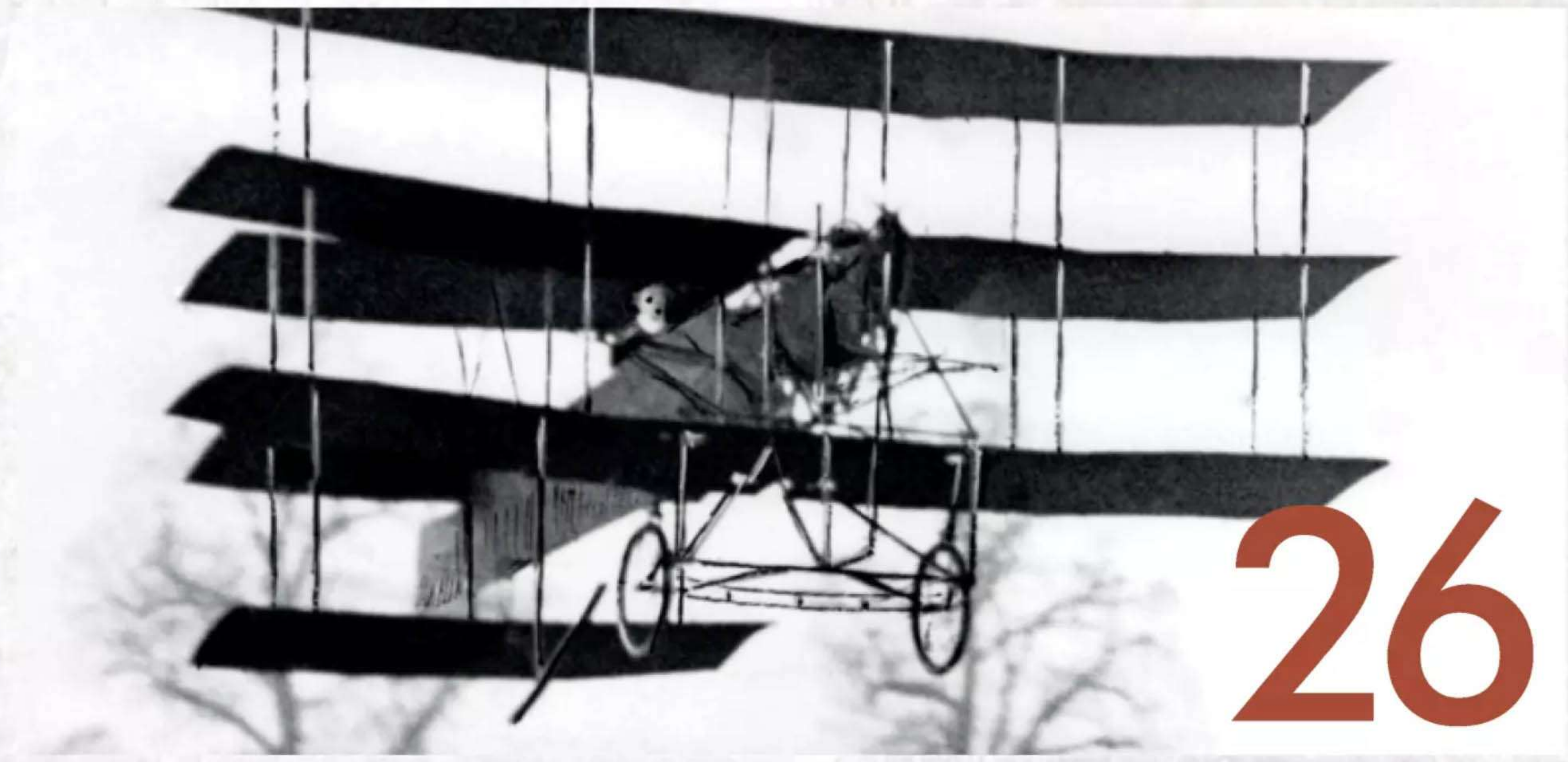

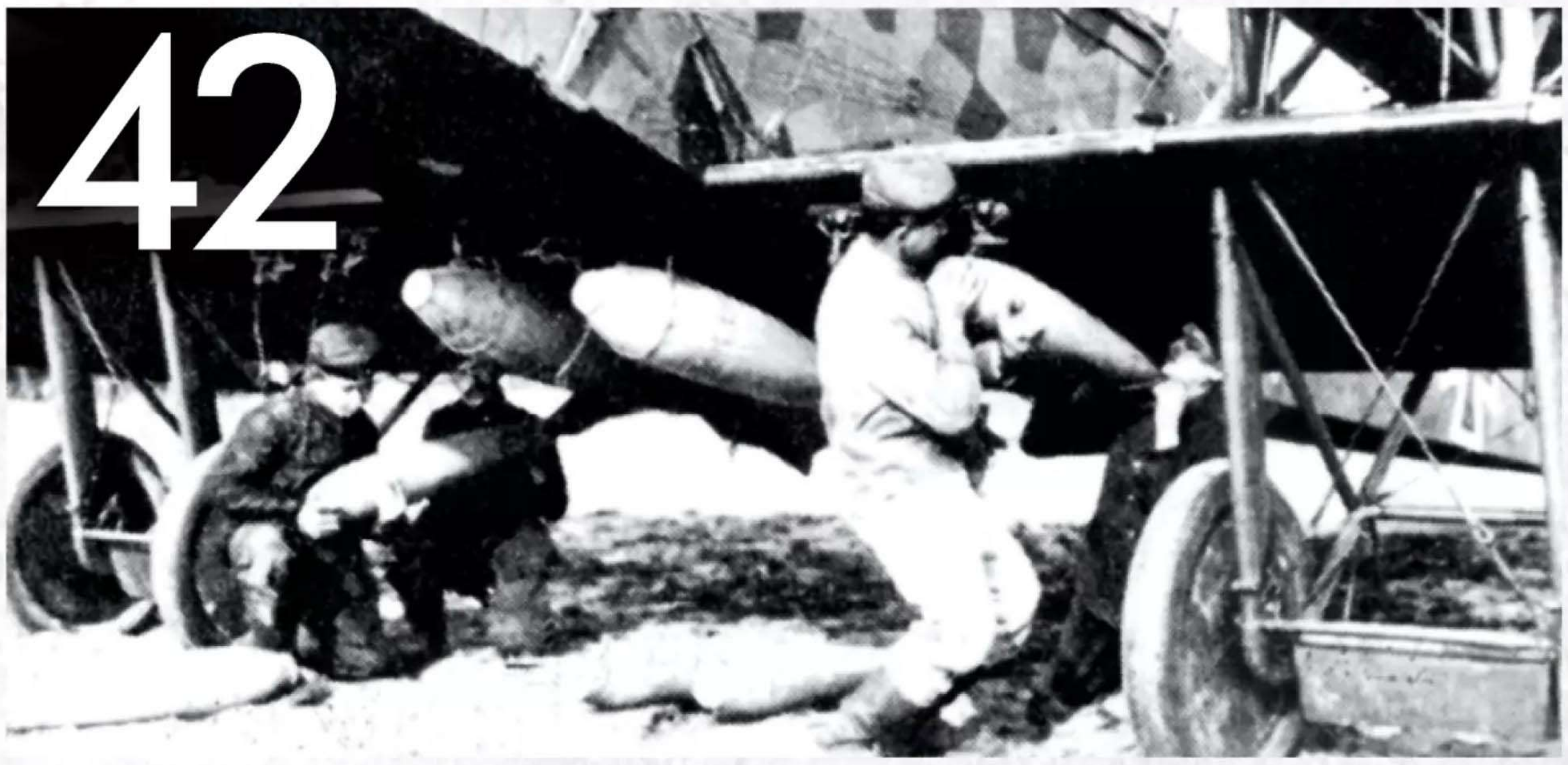

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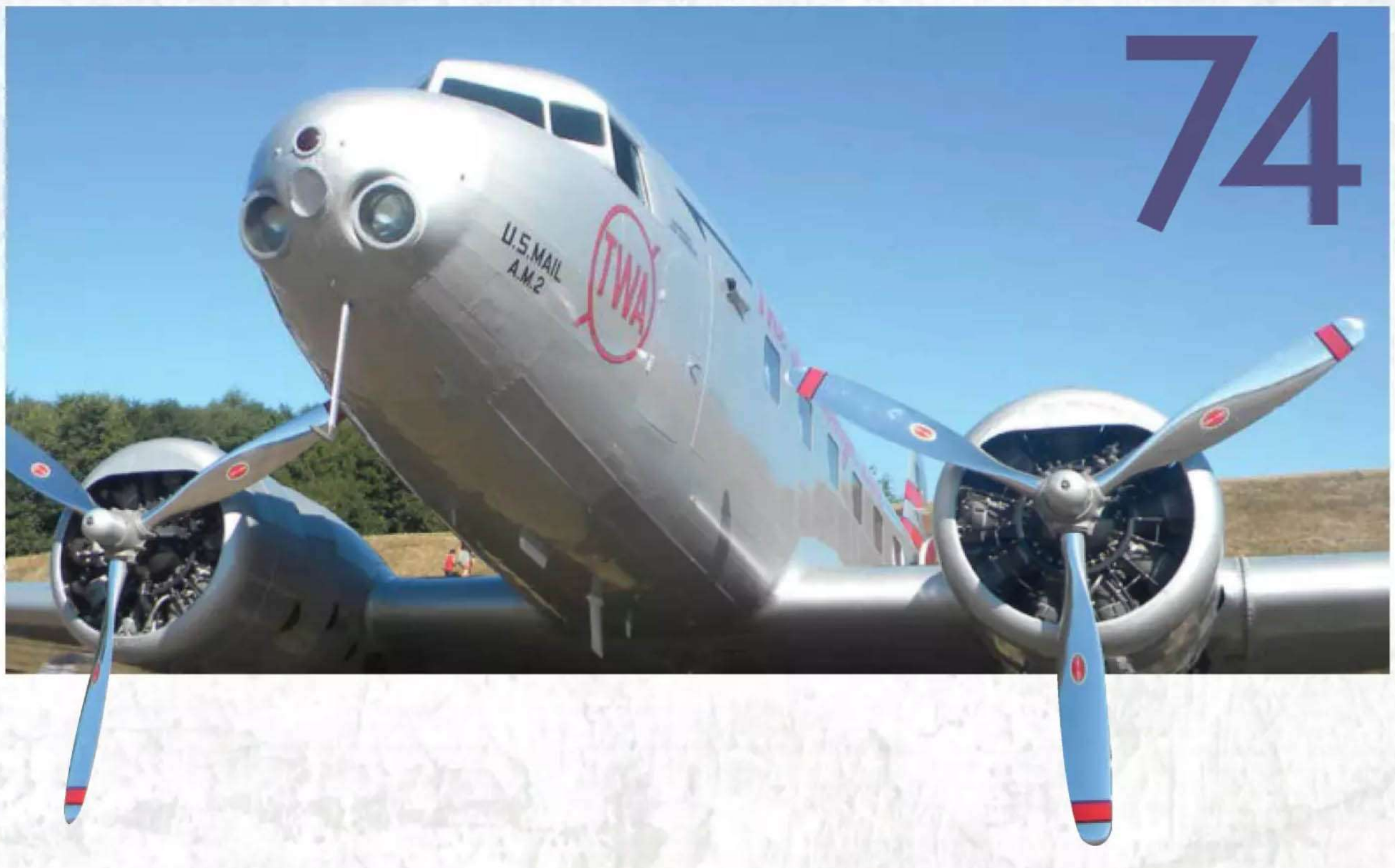

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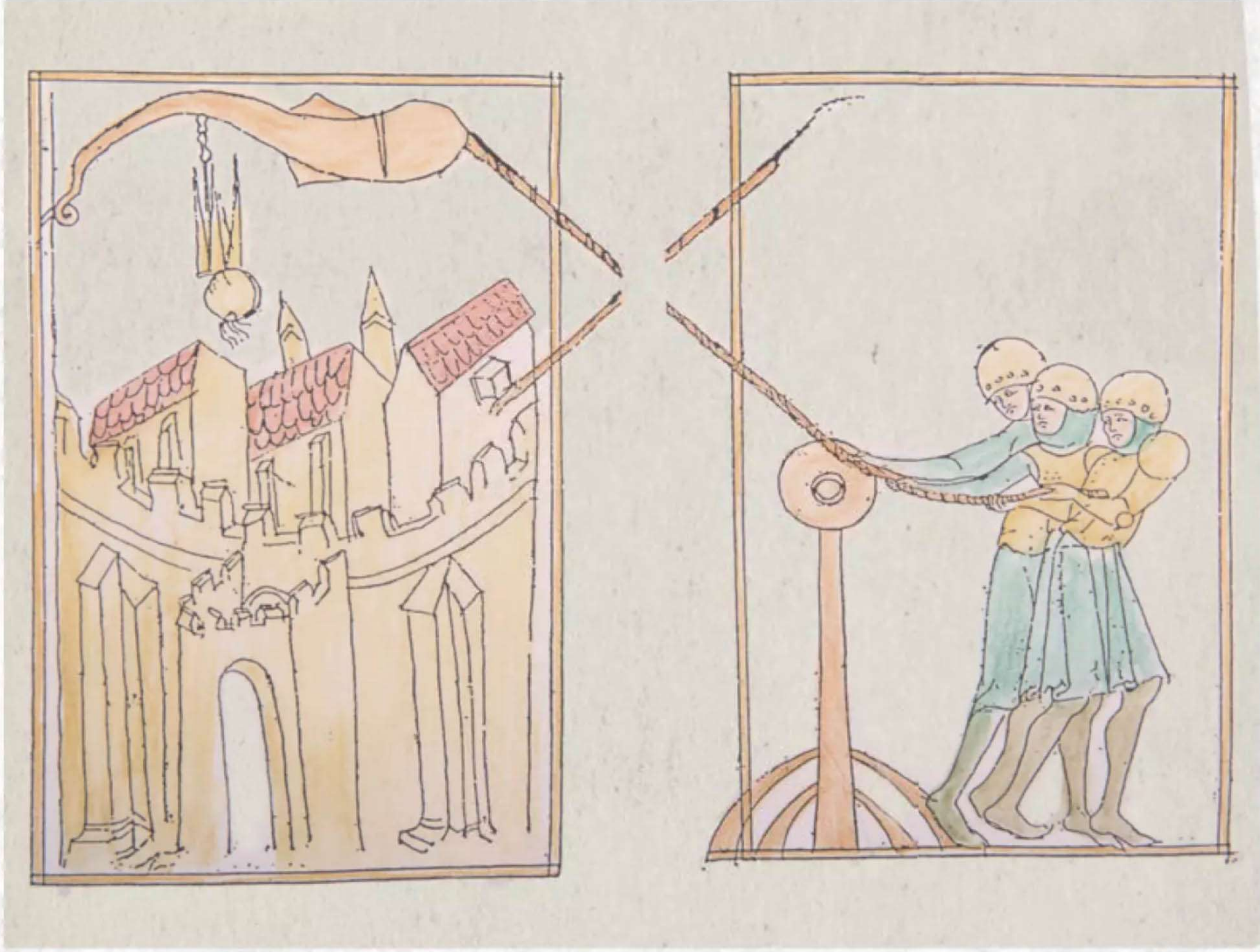
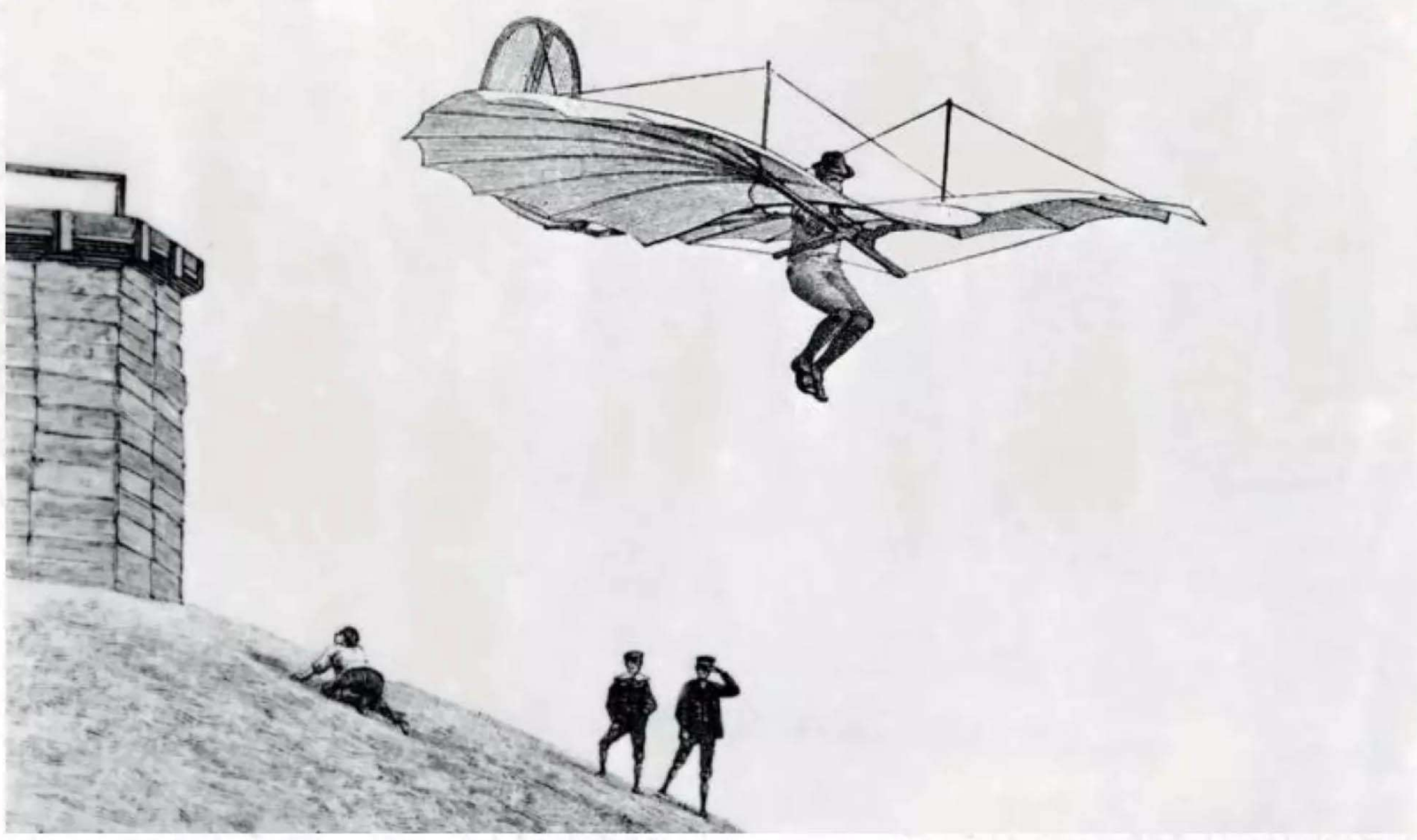
TAKING FLIGHT

Watching birds in flight, it is easy to understand how our ancestors became fascinated by the idea of flying. History is littered with stories of would-be fliers who jumped from towers with artificial wings strapped to their arms. Inevitably, the wing-flapping "bird man" would plummet to the ground with dire consequences. Ancient myths tell of flying machines even more fanciful but there was one device, the kite, which did take to the air. Created in ancient China, there are even accounts of people attempting to fly attached to kites.

But it was with balloons that the first successful human flights were made. On 21 November 1783, Pilâtre de Rozier and the Marquis d'Arlandes made the first free flight, in a hot air balloon created by the Montgolfier Brothers. They flew from Paris for eight kilometres (five miles) at a height of 900 metres (3,000 feet). Work on hydrogen-filled balloons had been taking place in parallel with the Montgolfier's experiments, and on 1 December 1783, Jacques Charles and a companion lifted off from Paris for the first manned ascent in a hydrogen-filled balloon. The first balloon crossing of the English Channel was made only two years later by Jean-Pierre Blanchard and John Jeffries. Ballooning became a popular sport but practical uses were also found for balloons in nineteenth-century warfare, either to carry messages or as observation platforms. Balloons, however, have the drawback of being at the mercy of the winds. Powered and controlled airships do not have this

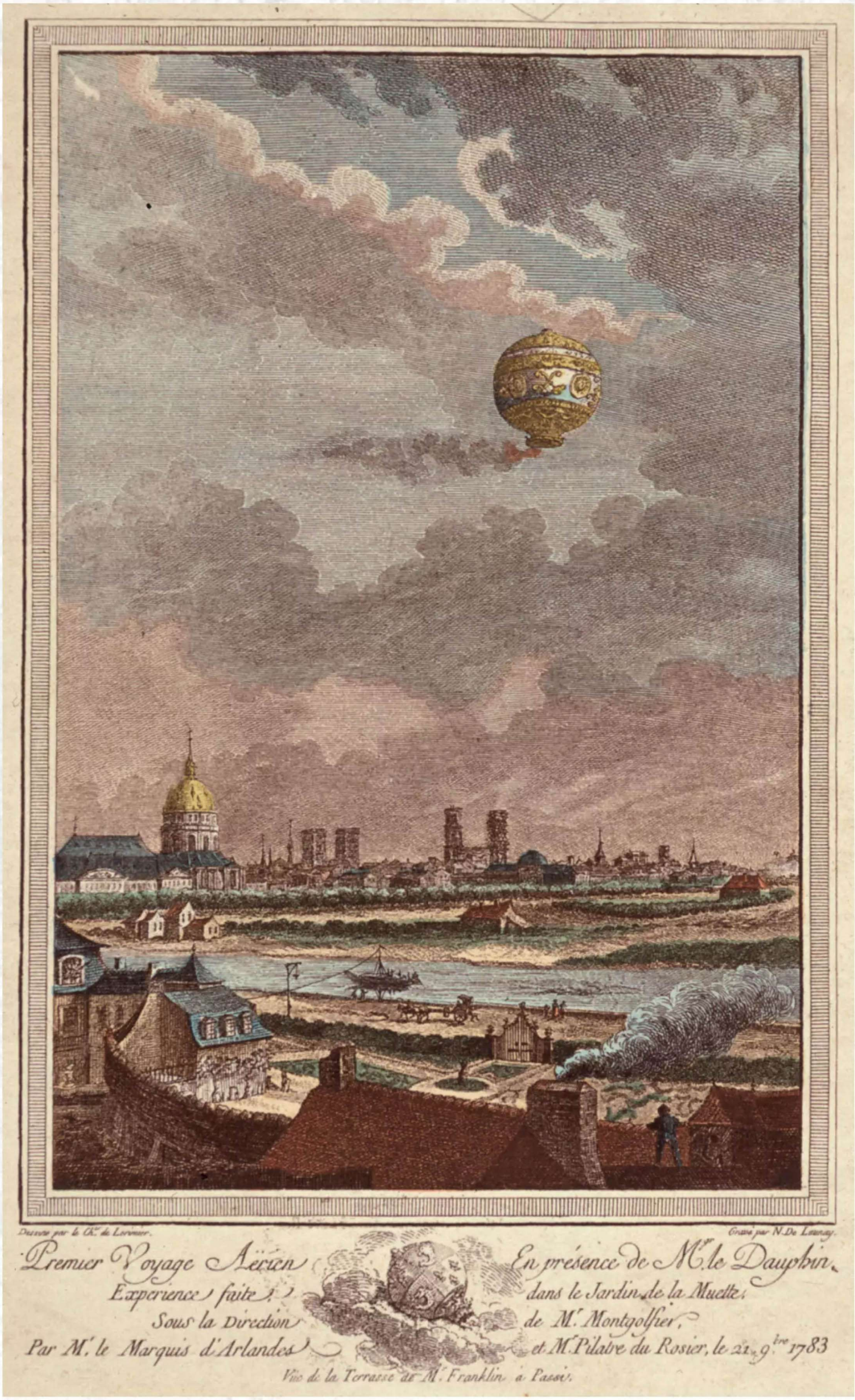


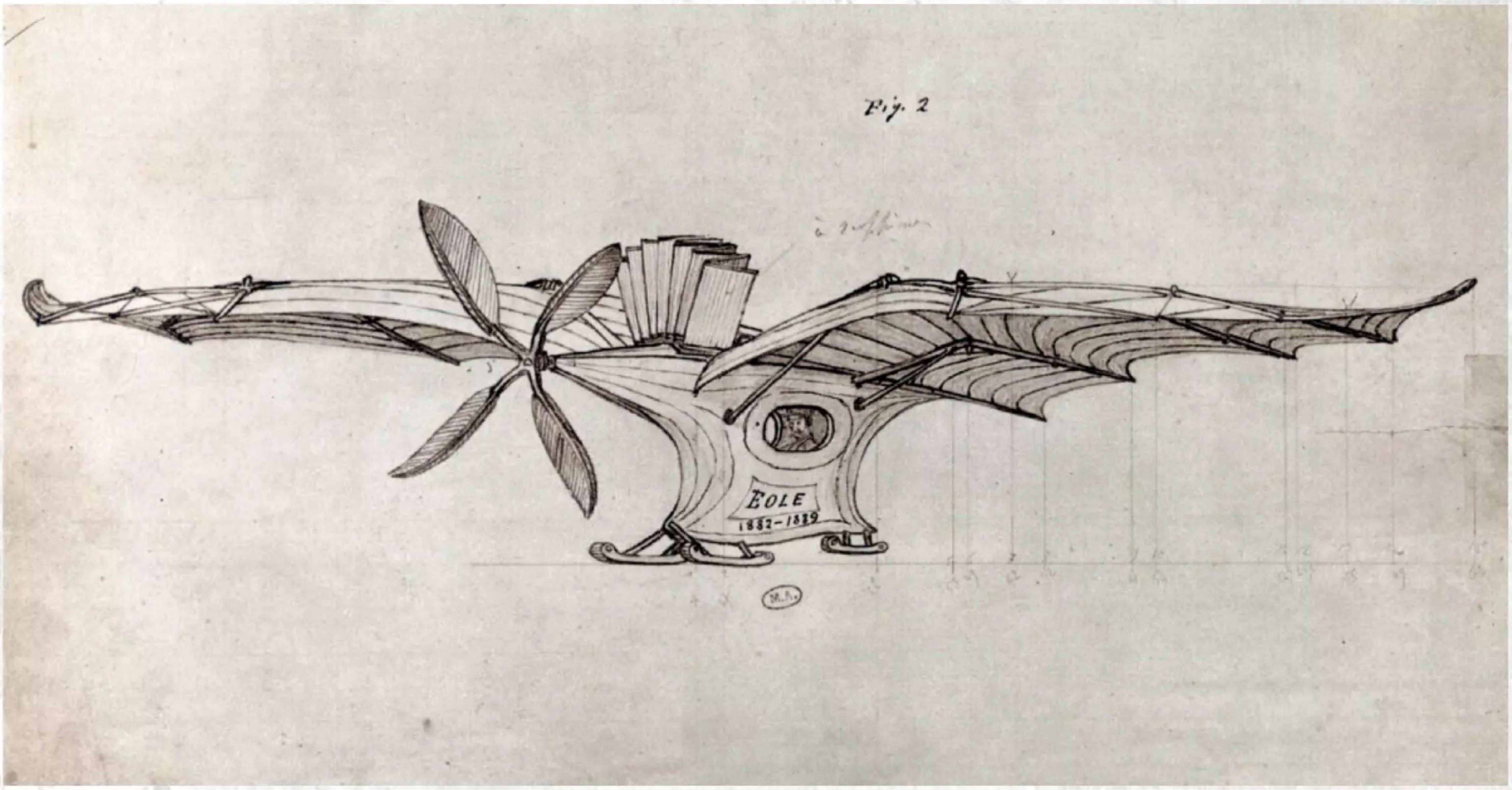


ABOVE RIGHT: A fourteenth-century manuscript showing a windsock kite carrying a bomb. Kites were introduced into Europe from China in the thirteenth century.

RIGHT: Otto Lilienthal making a flight in 1894 in a monoplane hang glider. Lilienthal controlled his gliders by the dangerous practise of shifting the position of his body to maintain stability.

OPPOSITE: Pilâtre de Rozier and the Marquis d'Arlandes made the first manned flight when they ascended over Paris in a Montgolfier hot air balloon on 21 November 1783. Ballooning developed in parallel, and often ahead of, heavier-than-air flight.


Dessiné par le Ch.er de Lorimier.
Gravé par N. De Launay.
Premier Voyage Aërien
En présence de M.gr le Dauphin.
Experience faite
dans le Jardin de la Muette,
Sous la Direction
de M.r Montgolfier,
Par M.r le Marquis d'Arlandes
et M.r Pilatre du Rosier, le 21. 9.bre 1783
Vüe de la Terrasse de M.r Franklin a Passi.



disadvantage. In 1852, Frenchman Henri Giffard's airship used a small steam engine to drive a propeller mounted under a cigar-shaped balloon to fly a distance of 27 kilometres (17 miles).

Englishman George Cayley was the first to make real theoretical and practical progress towards heavier-than-air flight. In his experiments, he investigated the lift and drag created by different wings at various speeds and angles. Cayley applied what he had learnt to a series of glider models. This work culminated in his 1853 glider in which his coachman made a flight of 450 metres (1,500 feet) across Brompton Dale in Yorkshire. Cayley's work influenced aerial pioneers for the next 50 years.

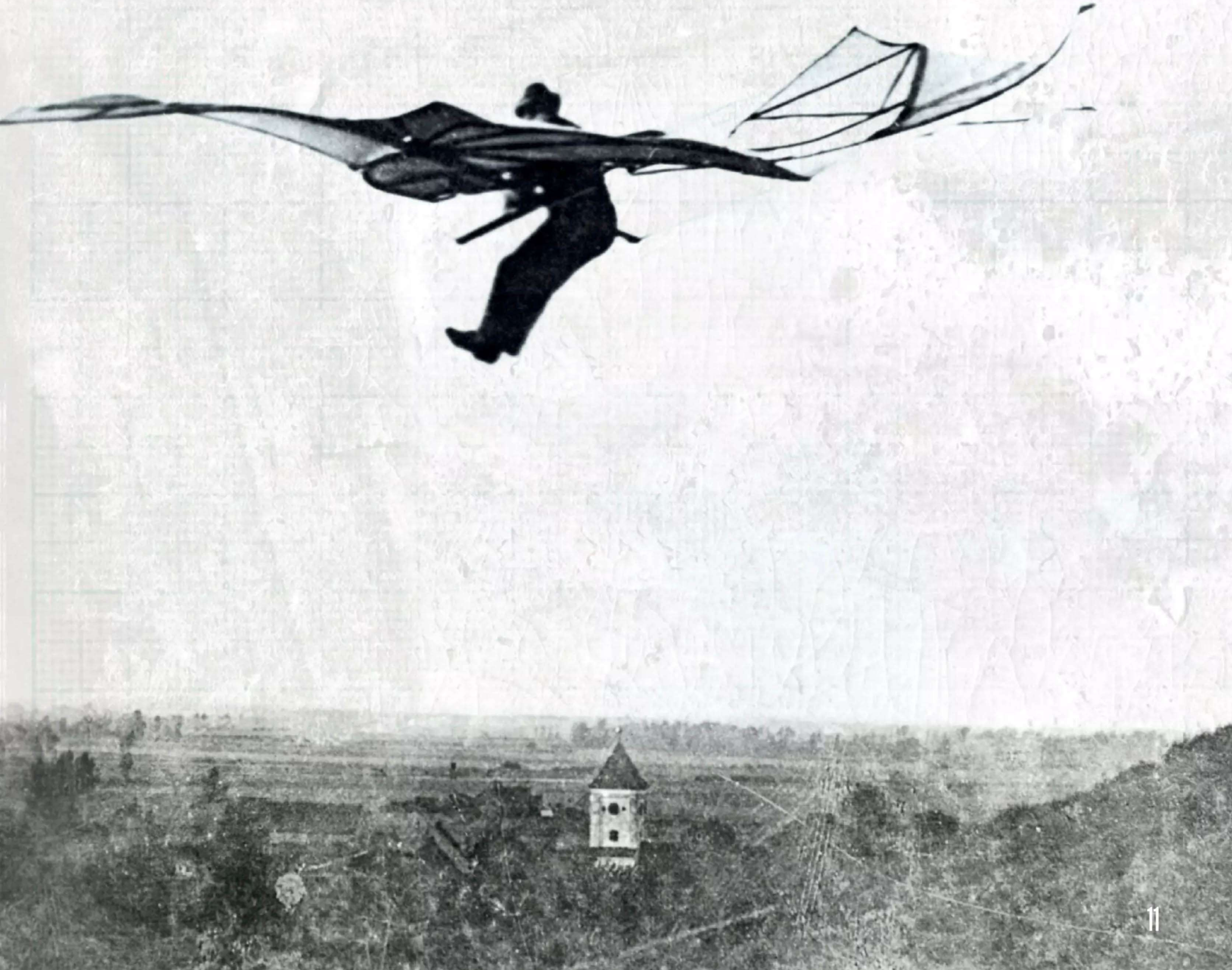
Some of the early pioneers who followed on from Cayley tried to build powered flying machines; others had more success with

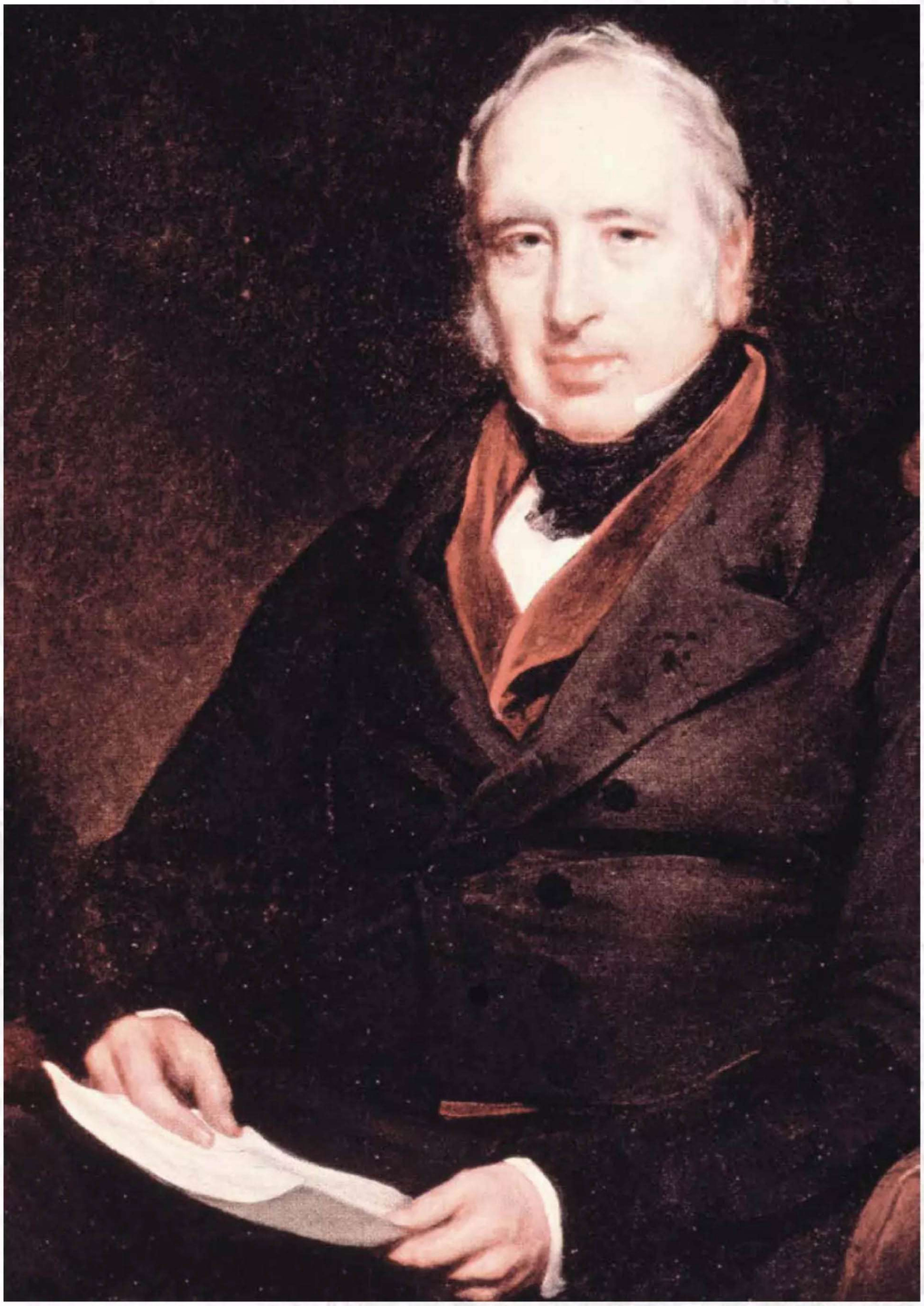
The Montgolfier Brothers

In 1782 Joseph-Michael (1740–1810) and Étienne (1745–1799) Montgolfier experimented with hot-air-filled silk bags which rose up because the heated air in the bags was lighter than the external air. However, the brothers did not realize this, believing that gas created by burning material caused the bags to rise. Nevertheless, in June 1783, their first public demonstration of a hot air balloon, consisting of an 11-metre (38-feet) paper-lined linen bag, was a success. In September of that year, at a royal demonstration at Versailles, a balloon was flown with a sheep, a rooster and a duck as its passengers. All returned safely to the ground. The first manned flight was made in November 1783.

LEFT: A drawing of Clément Ader's steam-powered Éole. Although not a practical and controllable flying machine, the Éole very briefly left the ground under its own power in 1890. Ader's next machine, the Avion III, failed to fly at all when tested in 1897.

BELOW: Otto Lilienthal making a flight in 1896 at Stölln near Berlin. Lilienthal controlled his gliders by the dangerous practise of shifting the position of his body to maintain stability. Lilienthal crashed and died in 1896 while flying a glider.





George Cayley
(1773–1857)

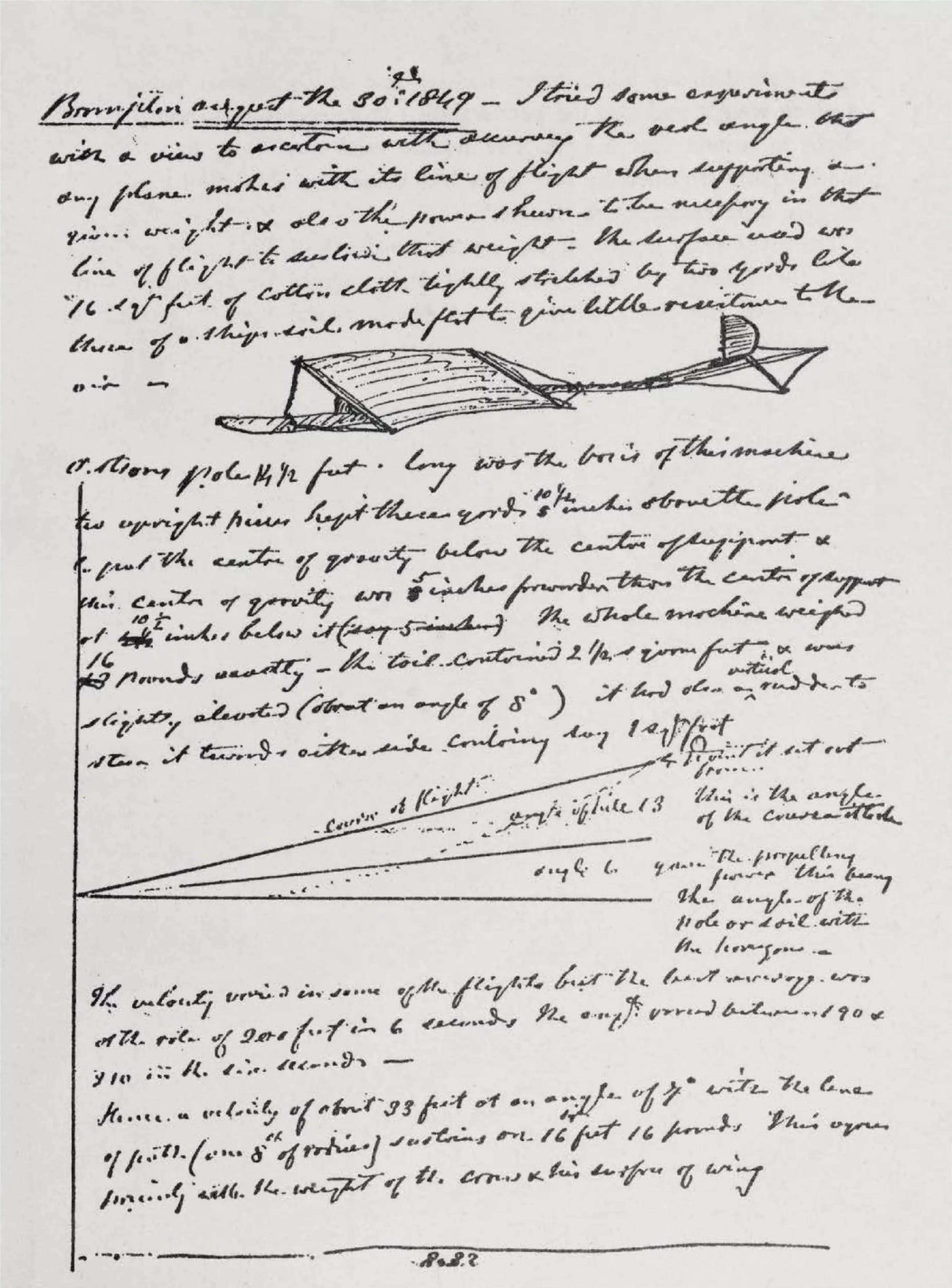
Sir George Cayley is sometimes referred to as "the father of aviation". He was an engineer and a Member of Parliament. He worked on a wide range of engineering projects but is best remembered for his pioneering work in aviation, developing the first proper understanding of the principles of flight. Cayley's 1804 model glider was similar in configuration to modern aircraft with monoplane wings towards the front and a tailplane with horizontal stabilizers and a vertical fin at the rear. His man-carrying glider first flew in 1853.

OPPOSITE: Sir George Cayley's notes and sketches of the glider experiments he made in the summer of 1849.

LEFT: Sir George Cayley "the father of aviation"

gliders. In 1890, French engineer Clement Ader claimed that his steam-powered Éole had flown. It managed 50 metres (165 feet) at a height of 20 centimetres (eight inches). Then in 1894, in England, Hiram Maxim tested a steam-powered biplane on rails which lifted briefly. Neither Maxim, Ader or other exponents of the power-centred approach to aeroplane development, including the American Samuel Pierpont Langley, fully considered how they might control their aircraft if they actually flew, unlike experimenters who concentrated on gliding. Chief among these was the German Otto Lilienthal who developed his flying skills as he tested a series of 18 gliders in more than 2,000 flights, some of which were over 300 metres (1,000 feet), until his death during a crash landing in 1896.

Lilienthal influenced the work of American engineer and gliding experimenter Octave Chanute, who would in turn become a friend and mentor to the Wright brothers. It was to be the Wrights who successfully moved from gliding to the first controlled powered flight.



Brompton August the 30th 1849 — I tried some experiments with a view to ascertain with accuracy the real angle that any plane makes with its line of flight when supporting a given weight & also the power shewn to be necessary in that line of flight to sustain that weight — the surface used was 16 sq feet of cotton cloth tightly stretched by two yards like those of a ships sail, made flat to give little resistance to the air —

A strong pole 14½ feet long was the basis of this machine two upright pieces kept these yards $\overset{10\frac{1}{2}}{5}$ inches above the pole to put the centre of gravity below the centre of support & this centre of gravity was ~~8~~ 5 inches forwarder than the centre of support & at ~~5½~~ 10½ inches below it ~~(say 5 inches)~~ The whole machine weighed ~~13~~ 16 pounds exactly — the tail contained 2½ sq. square feet & was slightly elevated (about an angle of 8°) it had also a vertical rudder to steer it towards either side containing say 1 sq foot

& point it set out from

Course of flight

angle of sail 13

This is the angle of the course attack

angle 6

gives the propelling power this being the angle of the pole or sail with the horizon —

The velocity varied in some of the flights but the best average was at the rate of 200 feet in 6 seconds the angle varied between 19 ? & 31 ? in the six seconds —

Hence a velocity of about 33 feet at an angle of 7° with the line of path (one 8th of radius) sustains on 16 feet 16 pounds This agrees precisely with the weight of the crow & his surface of wing

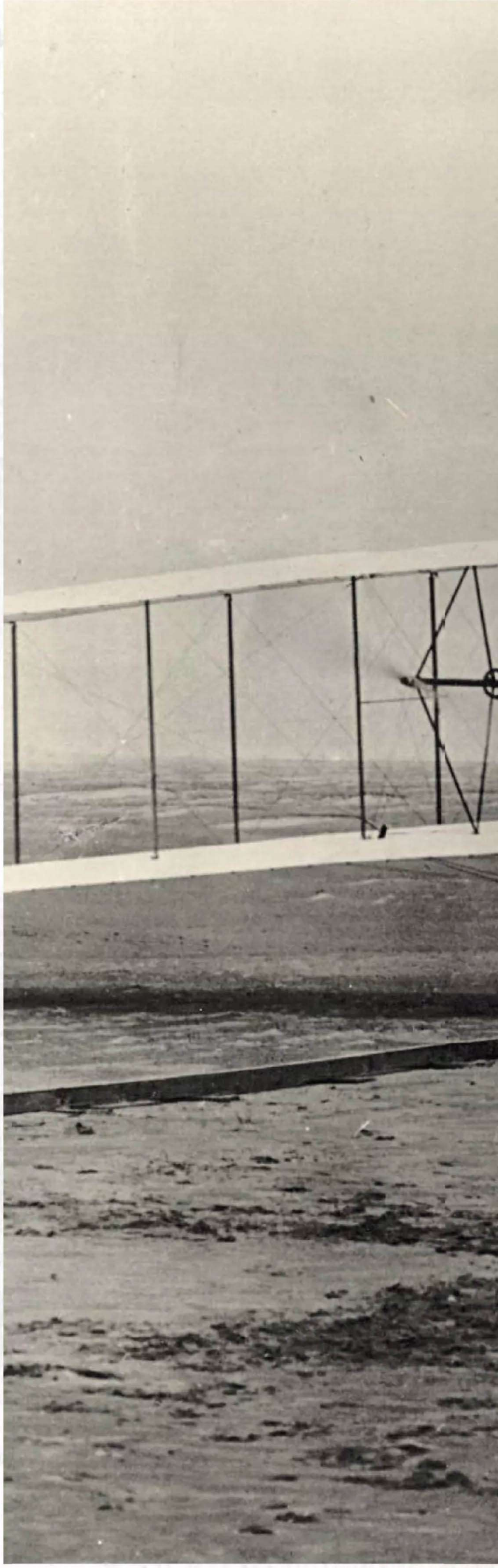
8.8.2

THE WRIGHT BROTHERS

Wilbur and Orville Wright had been interested in the problems associated with mechanical and human flight since childhood. They eagerly followed the fortunes of pioneers such as Otto Lilienthal, and in 1899 began to study the subject in depth. They requested all of the information then available on the subject from the Smithsonian, a US institution already deeply involved with aviation experiments, and identified the areas that needed further investigation.

They initially focused on "control", surmising that sustained flight would be achieved if adjustments could be continually made to the balance of a craft in order to keep it stable. To achieve this goal, Wilbur and Orville developed the idea of "wing warping"; a process that involved twisting the flying surface to alter the flow of air and thus change the direction of the machine.

By September 1900, the Wrights had perfected the first of their experimental gliders and chosen Kitty Hawk, North Carolina, as a suitable location for trials. The glider was a success and the all-important wing warping control system worked well. But it did not generate as much lift as they had hoped. Further trials on a new glider, with redeveloped wings based on the work of earlier aviators, were even more disappointing. The brothers began to suspect that the calculations of earlier pioneers were crucially defective.



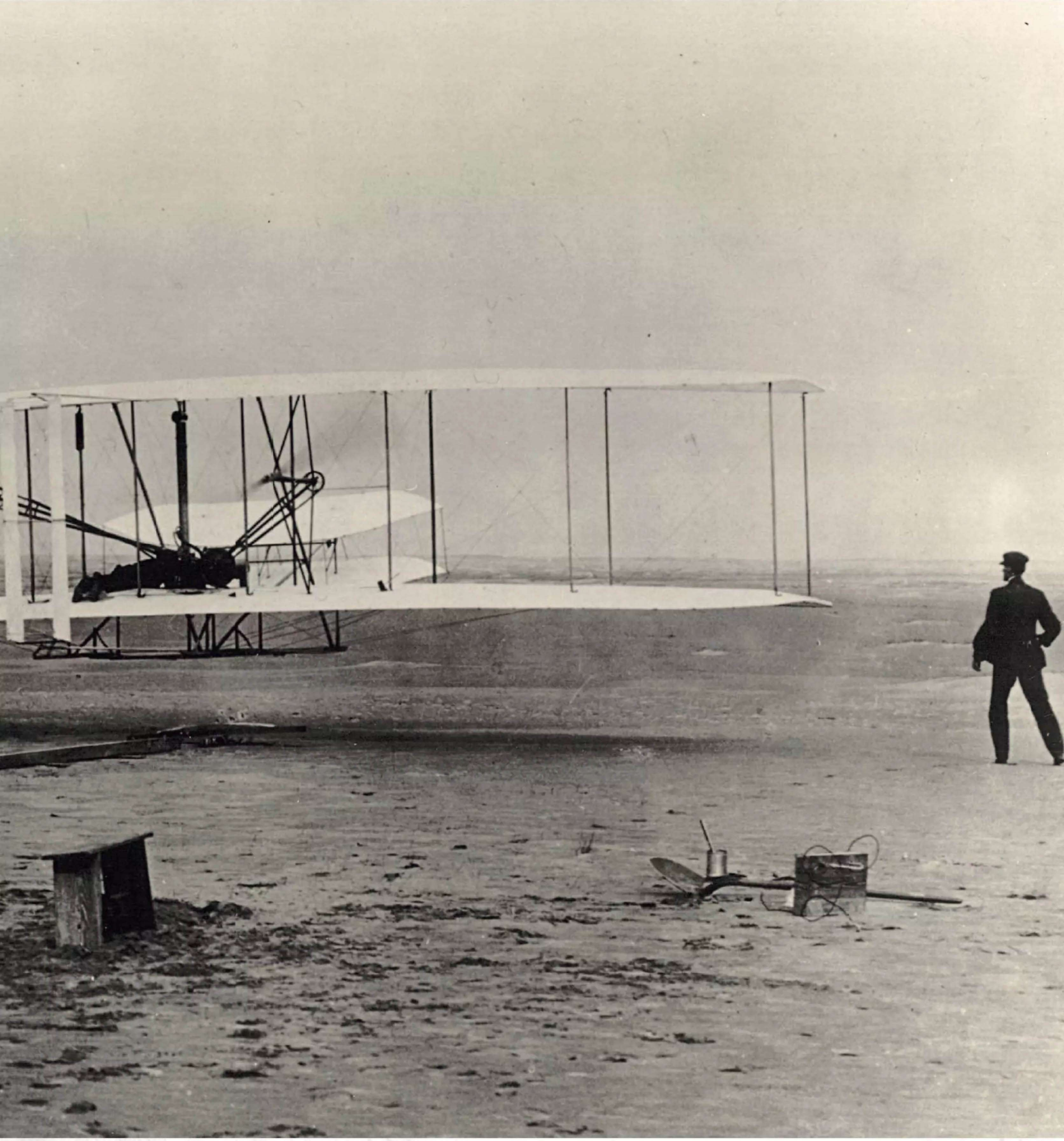
RIGHT: The first flight photograph by John Daniels of Kill Devil HIlls lifesaving station, 17 December 1903.

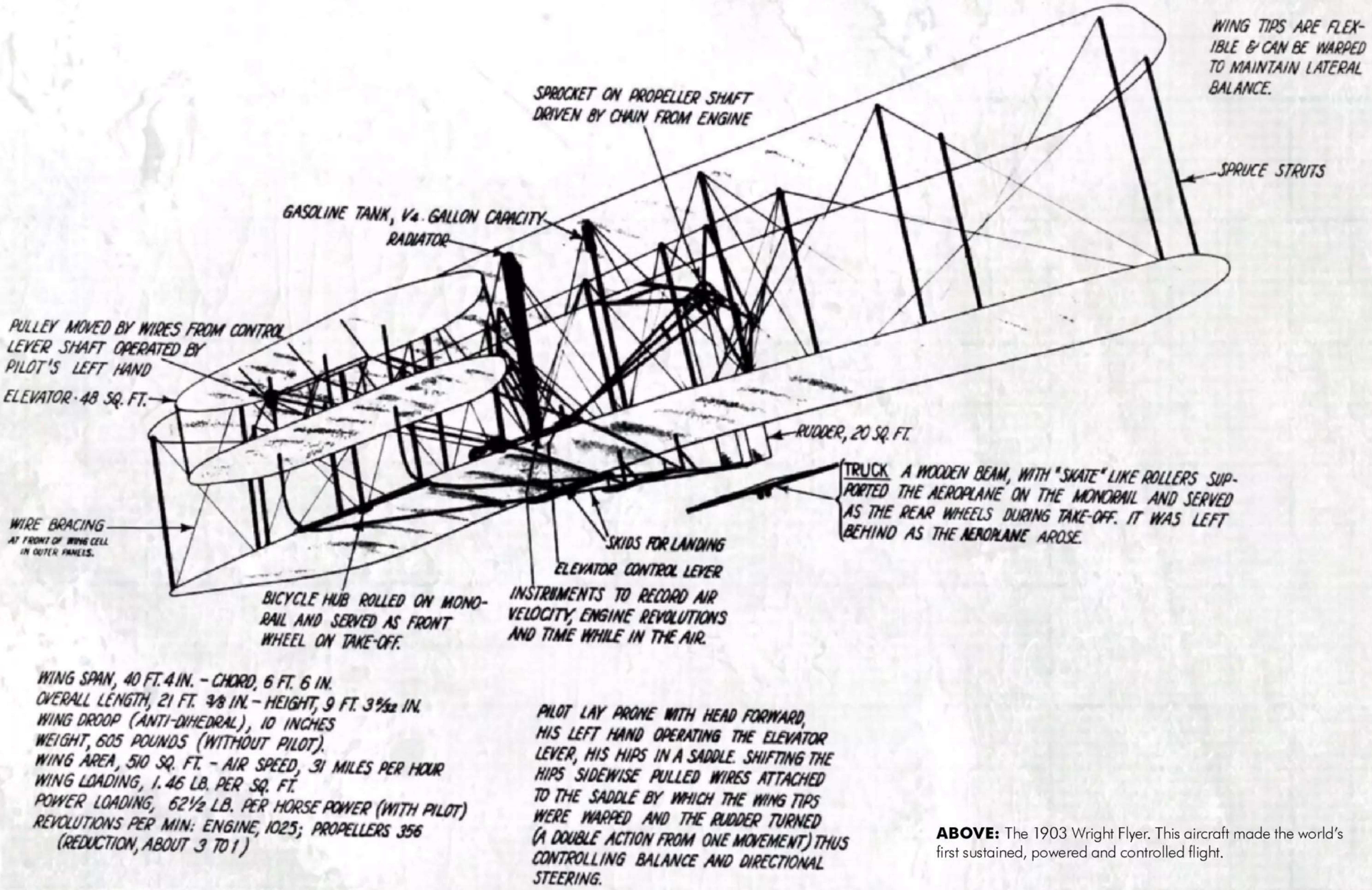
The Wright Brothers

Wilbur (1867–1912) and Orville (1871–1948) were the sons of Milton and Susan Wright. Neither attended university, instead running several businesses, including the Wright Cycle Co. The profits from this successful enterprise were ploughed into their aviation experiments.

In approach they were both meticulous and systematic. They matched their practical engineering skills with the ability to solve complex theoretical and scientific problems. The brothers combined this bookish intelligence with real passion for their work and the cool physical courage needed to test-fly their designs.

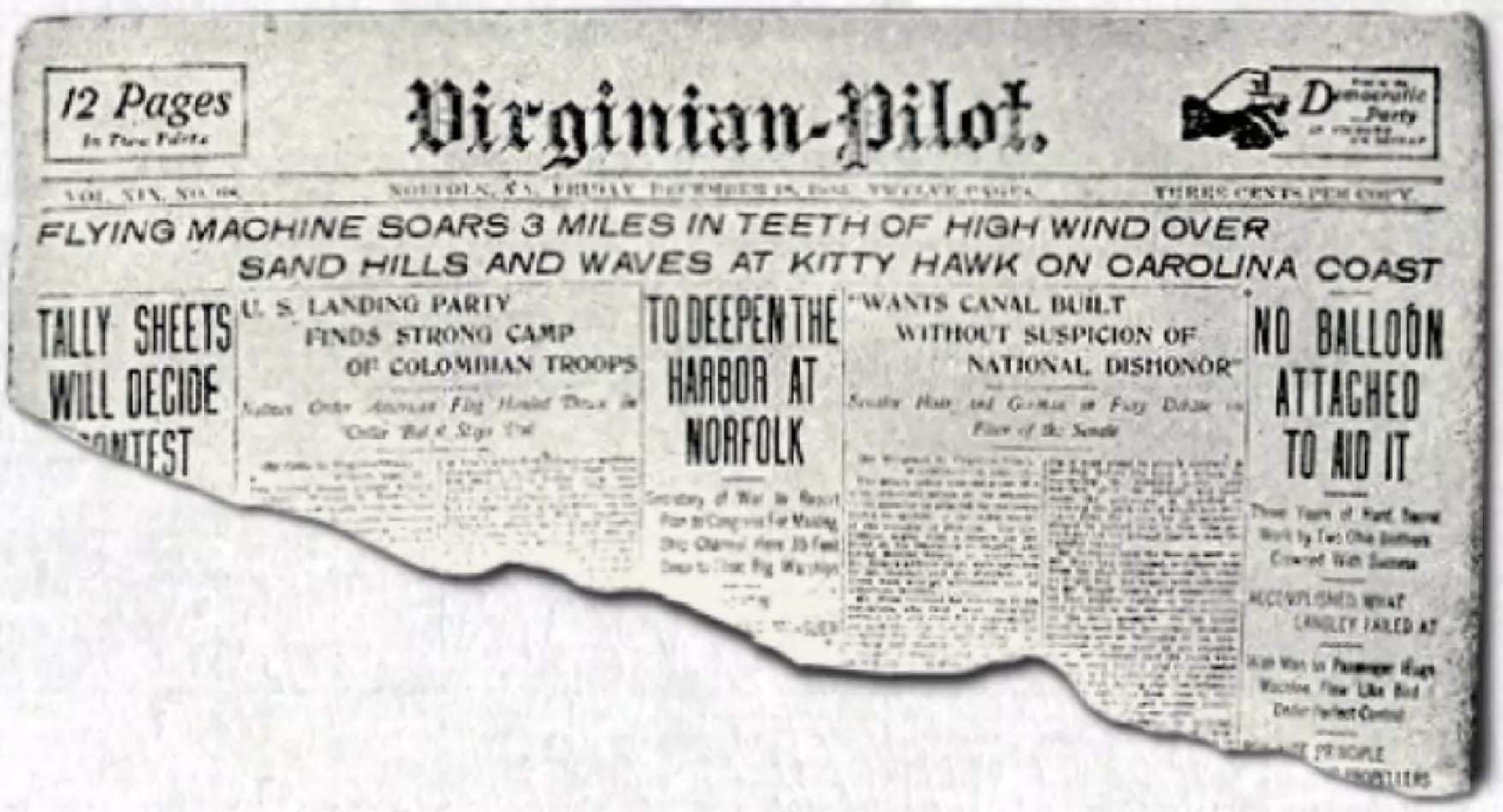
LEFT: Orville and Wilbur Wright in their home town of Dayton, Ohio in 1909. Although the brothers were close from childhood, they often argued fiercely about the details of their work and challenged each other's point of view. This ultimately helped them to successfully develop their ideas and turn them into practical working machines.




WING TIPS ARE FLEXIBLE & CAN BE WARPED TO MAINTAIN LATERAL BALANCE.
SPROCKET ON PROPELLER SHAFT DRIVEN BY CHAIN FROM ENGINE
SPRUCE STRUTS
GASOLINE TANK, 1/4 GALLON CAPACITY
RADIATOR
PULLEY MOVED BY WIRES FROM CONTROL LEVER SHAFT OPERATED BY PILOT'S LEFT HAND
ELEVATOR · 48 SQ. FT.
RUDDER, 20 SQ. FT.
TRUCK A WOODEN BEAM, WITH "SKATE" LIKE ROLLERS SUPPORTED THE AEROPLANE ON THE MONORAIL AND SERVED AS THE REAR WHEELS DURING TAKE-OFF. IT WAS LEFT BEHIND AS THE AEROPLANE AROSE.
WIRE BRACING AT FRONT OF WING CELL IN OUTER PANELS.
SKIDS FOR LANDING
ELEVATOR CONTROL LEVER
BICYCLE HUB ROLLED ON MONORAIL AND SERVED AS FRONT WHEEL ON TAKE-OFF.
INSTRUMENTS TO RECORD AIR VELOCITY, ENGINE REVOLUTIONS AND TIME WHILE IN THE AIR.
WING SPAN, 40 FT. 4 IN. - CHORD, 6 FT. 6 IN.
OVERALL LENGTH, 21 FT. 3/8 IN. - HEIGHT, 9 FT. 3 5/32 IN.
WING DROOP (ANTI-DIHEDRAL), 10 INCHES
WEIGHT, 605 POUNDS (WITHOUT PILOT).
WING AREA, 510 SQ. FT. - AIR SPEED, 31 MILES PER HOUR
WING LOADING, 1.46 LB. PER SQ. FT.
POWER LOADING, 62½ LB. PER HORSE POWER (WITH PILOT)
REVOLUTIONS PER MIN: ENGINE, 1025; PROPELLERS 356 (REDUCTION, ABOUT 3 TO 1)
PILOT LAY PRONE WITH HEAD FORWARD, HIS LEFT HAND OPERATING THE ELEVATOR LEVER, HIS HIPS IN A SADDLE. SHIFTING THE HIPS SIDEWISE PULLED WIRES ATTACHED TO THE SADDLE BY WHICH THE WING TIPS WERE WARPED AND THE RUDDER TURNED (A DOUBLE ACTION FROM ONE MOVEMENT) THUS CONTROLLING BALANCE AND DIRECTIONAL STEERING.

ABOVE: The 1903 Wright Flyer. This aircraft made the world's first sustained, powered and controlled flight.

WILBUR
WRIGHT
ORVILLE
WRIGHT



12 Pages

Virginian-Pilot.

FLYING MACHINE SOARS 3 MILES IN TEETH OF HIGH WIND OVER SAND HILLS AND WAVES AT KITTY HAWK ON CAROLINA COAST

TALLY SHEETS WILL DECIDE CONTEST

U. S. LANDING PARTY FINDS STRONG CAMP OF COLOMBIAN TROOPS

TO DEEPEN THE HARBOR AT NORFOLK

"WANTS CANAL BUILT WITHOUT SUSPICION OF NATIONAL DISHONOR"

NO BALLOON ATTACHED TO AID IT

ACCOMPLISHED WHAT LANGLEY FAILED AT

ABOVE: The front page from the appropriately named Virginian-Pilot newspaper of 18 December 1903 records the achievement of the Wright brothers the day before at Kitty Hawk.

LEFT: A granite monument to the Wright Brothers stands at Kill Devil Hills, North Carolina. The inscription reads "In commemoration of the conquest of the air by the brothers Wilbur and Orville Wright. Conceived by genius. Achieved by dauntless resolution and unconquerable faith".

Wilbur and Orville commenced their own experiments, which ultimately completely reworked those calculations. By mounting miniature experimental wing shapes on the front of a bicycle and then by using a specially-built wind-tunnel, the Wrights produced extremely accurate measurements that they then applied to their wing designs. In 1902, they tested a glider built using the data they had produced. When they added moveable vertical fins to the design, linked to the wing warping system, they soon began to glide for distances of up to 200 metres (656 feet). Control had been mastered.

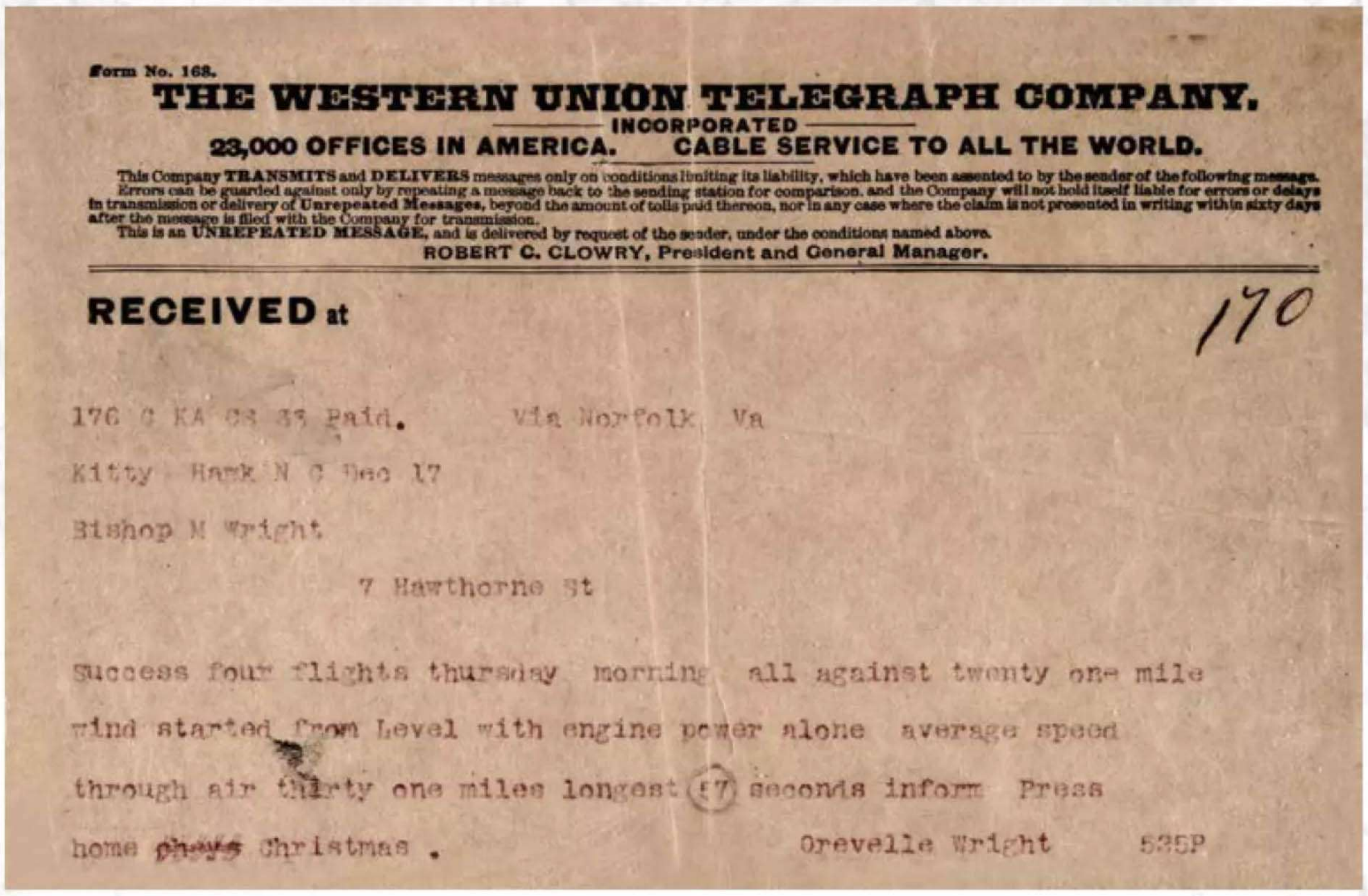
The brothers then turned their attention to "power". They needed a light yet powerful engine, and none of the existing models were good enough. The Wrights decided to produce their own, asking their assistant Charlie Taylor to help. The resulting motor was a triumph of efficient design, weighing 81.65 kilograms (180 pounds) and delivering 12 horsepower. Designing an efficient propeller proved more complicated; working out the mathematical and physical principles involved taxed the brothers' skills enormously, but it also demonstrated the strength and value of their partnership. As Orville wrote later, "Our minds became so obsessed with it that we could do little other work. We engaged in innumerable discussions, and often after an hour or so of heated argument, we would discover that we were as far from agreement as when we started, but that both had changed to the other's original position in the discussion."

Eventually, the Wrights overcame the propeller issue, and they returned to Kitty Hawk in September 1903, with all of the components seemingly in place. Their attention was now firmly fixed on achieving sustained flight. Events elsewhere added impetus to their work, as a fellow aviation experimenter, Samuel P Langley, was preparing to launch his new Aerodrome.

On 17 December 1903, after several weeks of frustrating setbacks, the Wrights launched their Flyer four times, with the men of the Kill Devil Hills lifesaving station acting as witnesses. With Orville at the controls, the machine initially spent 12 seconds in the air and covered a distance of 36.6 metres (120 feet). Two further attempts produced flights of greater distance. Then at noon, Wilbur began the fourth trip. This time the Flyer flew for an astonishing 59 seconds, a distance of 259.7 metres (852 feet). These two very special men from Ohio had achieved what many thought was impossible. Others would soon follow in their footsteps, but the honour of being first was theirs.

Samuel P Langley
(1834–1906)

Samuel Pierpont Langley was one of the Wrights' most distinguished competitors. He was a gifted scientist and astronomer, who had gained a significant reputation in these fields before turning his attention to the problem of manned flight. He became Secretary of the Smithsonian Institution in 1887, which coincided with his increasing interest in aviation. First, he experimented with rubber-band, then steam-powered models. Then, using the resources of the Smithsonian, he progressed to build his famous Aerodrome. Langley's approach was the opposite of the Wrights'. He believed that given enough power, as long as the machine was inherently stable, it would fly. The result of this conviction was disappointment for Langley and Charles Manly, the engineer who had invented the powerplant for the Aerodrome and was chosen to test-fly it. During its December 1903 flight, Langley's massive machine was a failure. Days later, the Wrights' contrasting approach was triumphantly vindicated.



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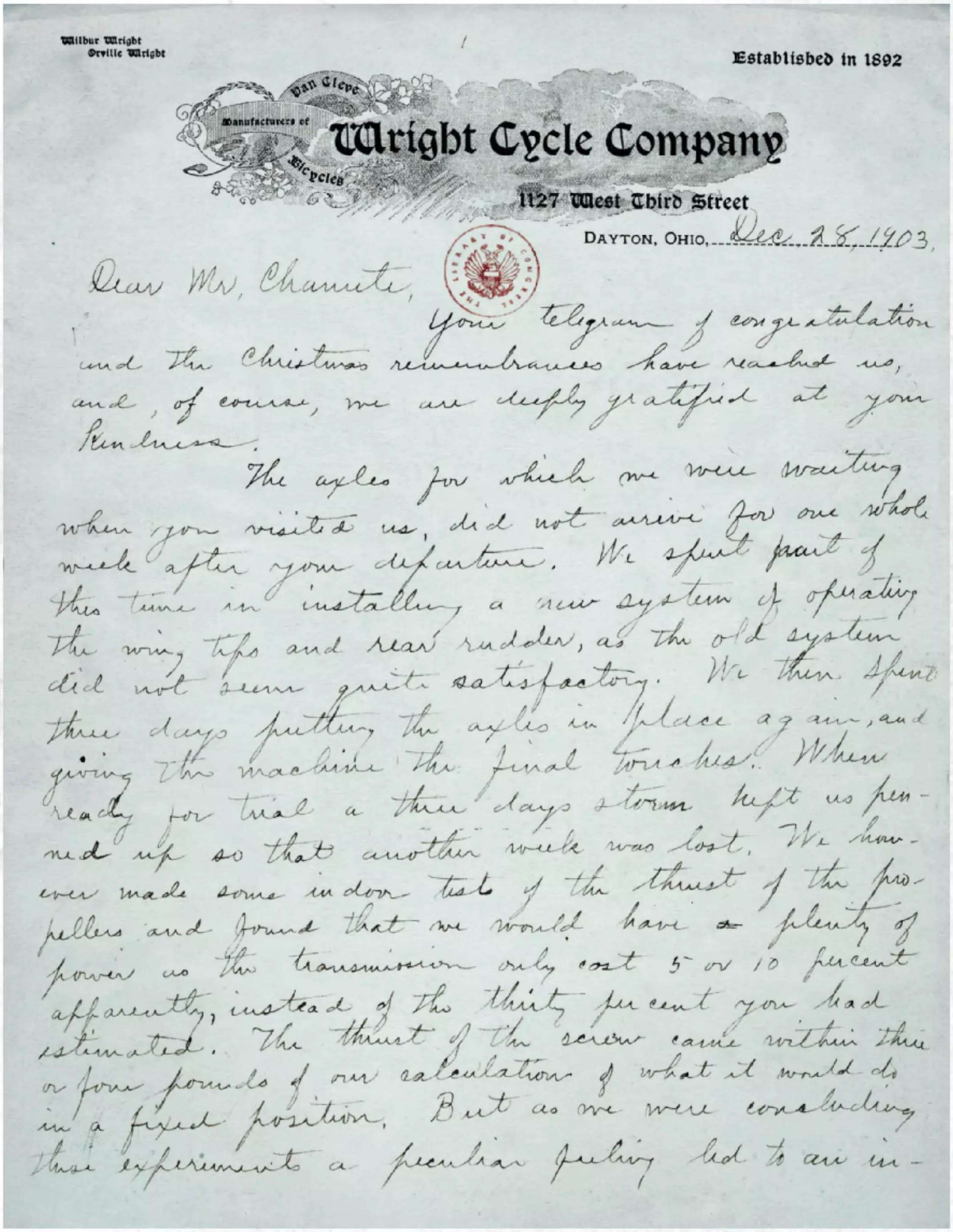
ROBERT C. CLOWRY, President and General Manager.

RECEIVED at 170

176 C KA CS 33 Paid. Via Norfolk Va
Kitty Hawk N C Dec 17
Bishop M Wright
7 Hawthorne St

Success four flights thursday morning all against twenty one mile
wind started from Level with engine power alone average speed
through air thirty one miles longest 57 seconds inform Press
home [illegible] Christmas . Orevelle Wright 535P

RIGHT: A telegram from Orville Wright to his father Bishop Milton Wright, informing him of the brothers' successful flights on 17 December 1903.



Wilbur Wright
Orville Wright

Established in 1892

Van Cleve
Manufacturers of
Bicycles

Wright Cycle Company
1127 West Third Street
DAYTON, OHIO, Dec. 28, 1903.

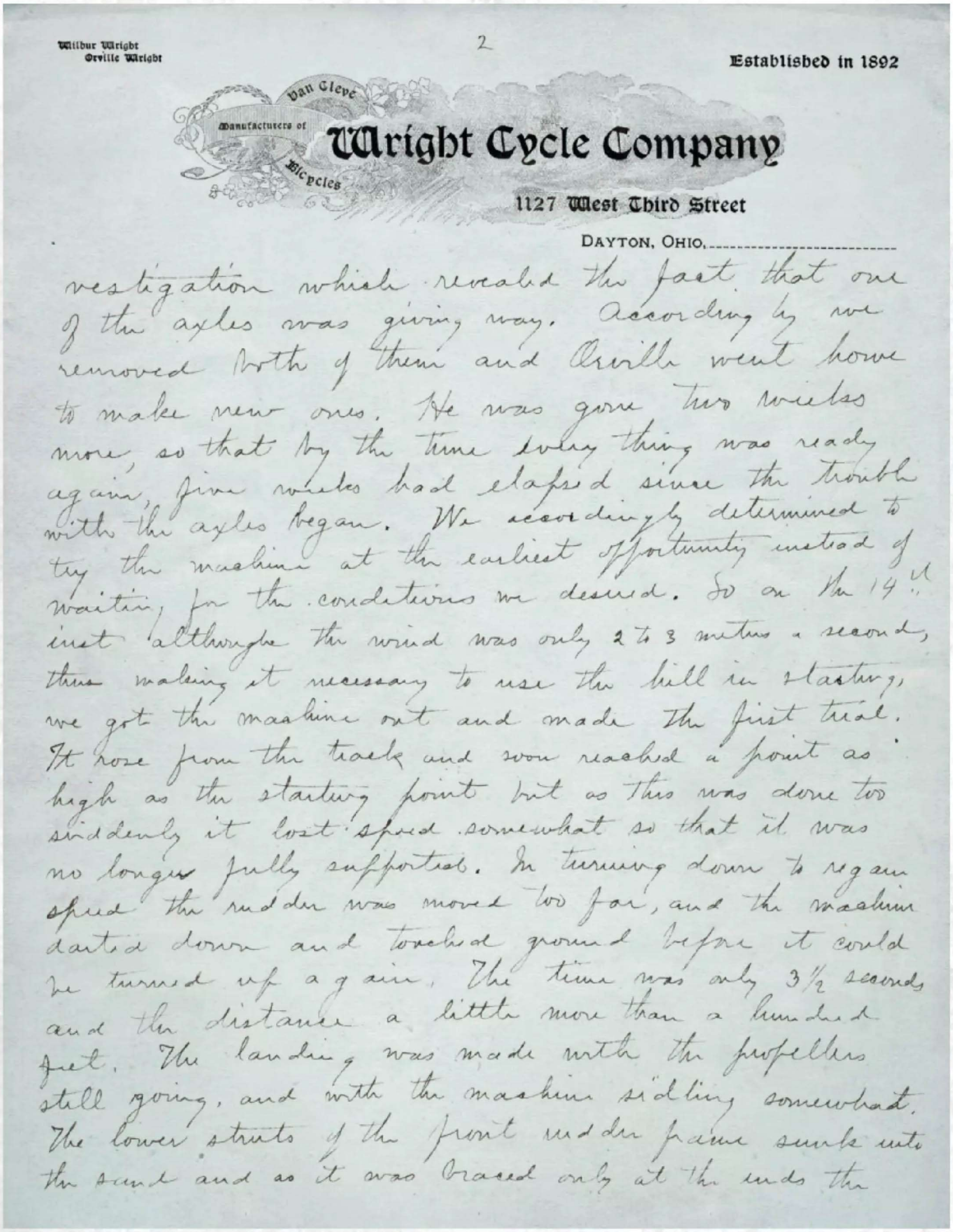
THE LIBRARY OF CONGRESS

Dear Mr. Chanute,

Your telegram of congratulation and the Christmas remembrances have reached us, and, of course, we are deeply gratified at your kindness.

The axles for which we were waiting when you visited us, did not arrive for one whole week after your departure. We spent part of this time in installing a new system of operating the wing tips and rear rudder, as the old system did not seem quite satisfactory. We then spent three days putting the axles in place again, and giving the machine the final touches. When ready for trial a three days storm kept us penned up so that another week was lost. We however made some indoor tests of the thrust of the propellers and found that we would have ~~a~~ plenty of power as the transmission only cost 5 or 10 percent apparently, instead of the thirty per cent you had estimated. The thrust of the screw came within three or four pounds of our calculation of what it would do in a fixed position. But as we were concluding these experiments a peculiar feeling led to an in-

ABOVE AND OPPOSITE: A letter dated 28 December 1903 from Wilbur Wright to fellow aviation pioneer Octave Chanute describing the Wright brothers' achievements earlier that month.



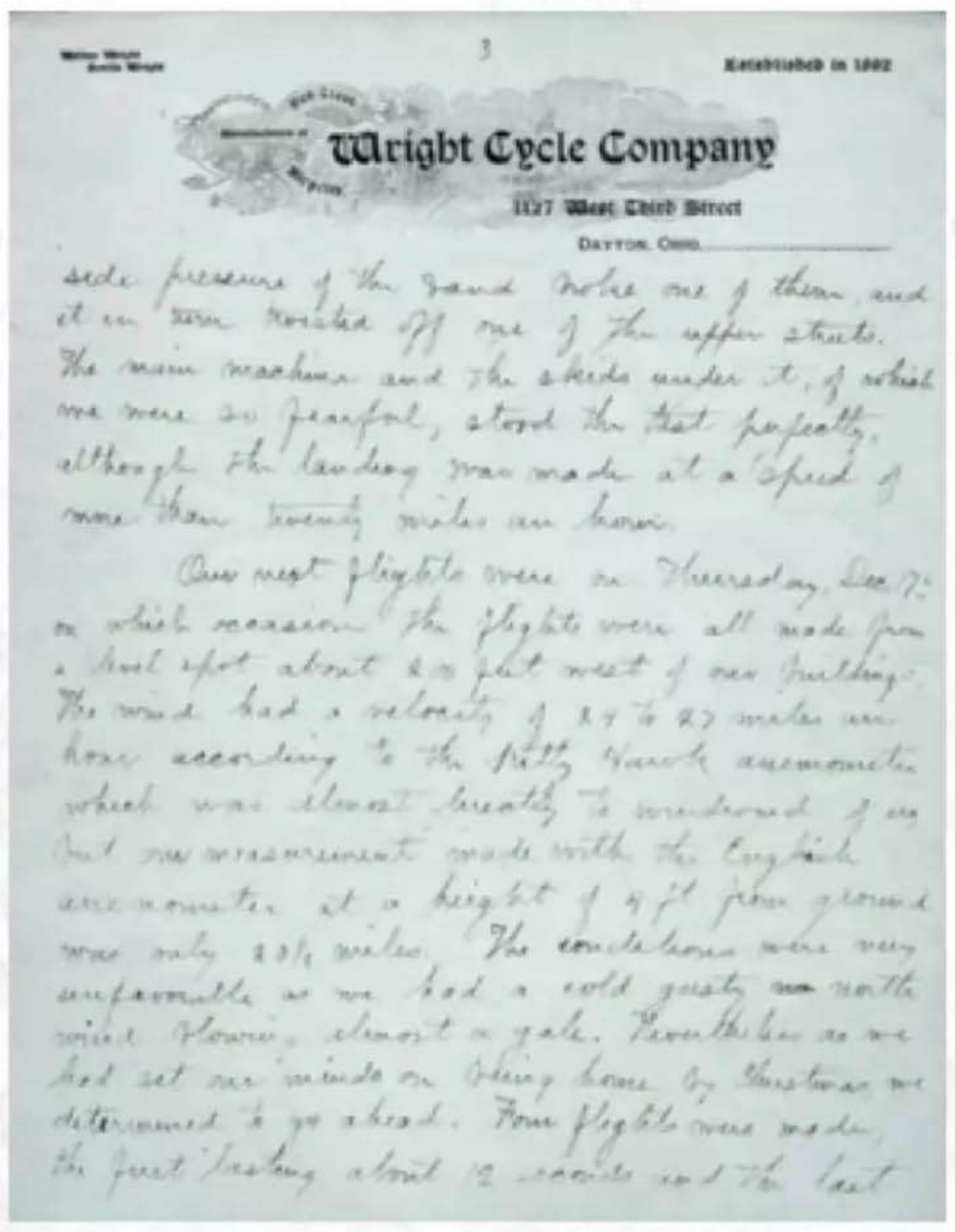
Wilbur Wright
Orville Wright

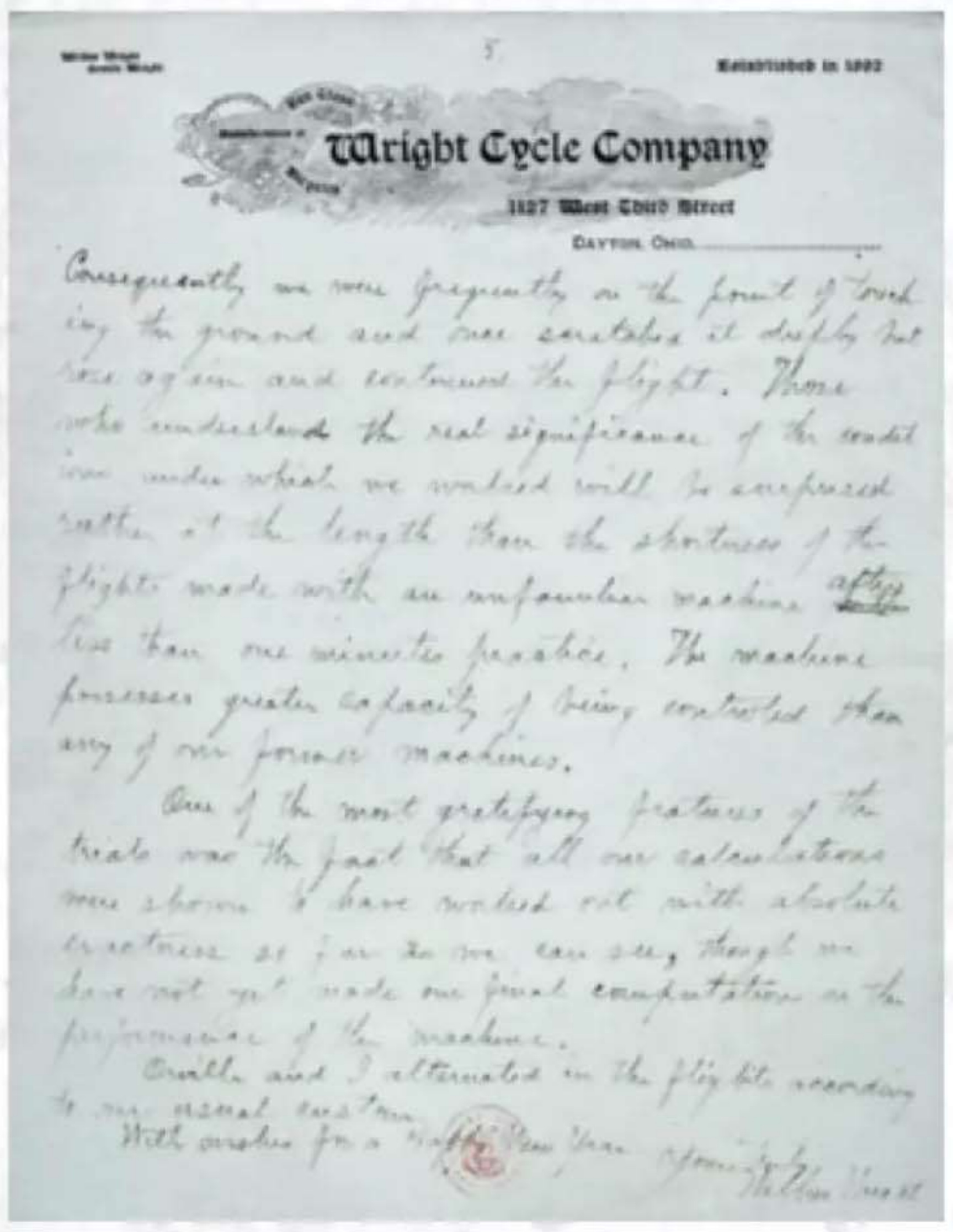
2

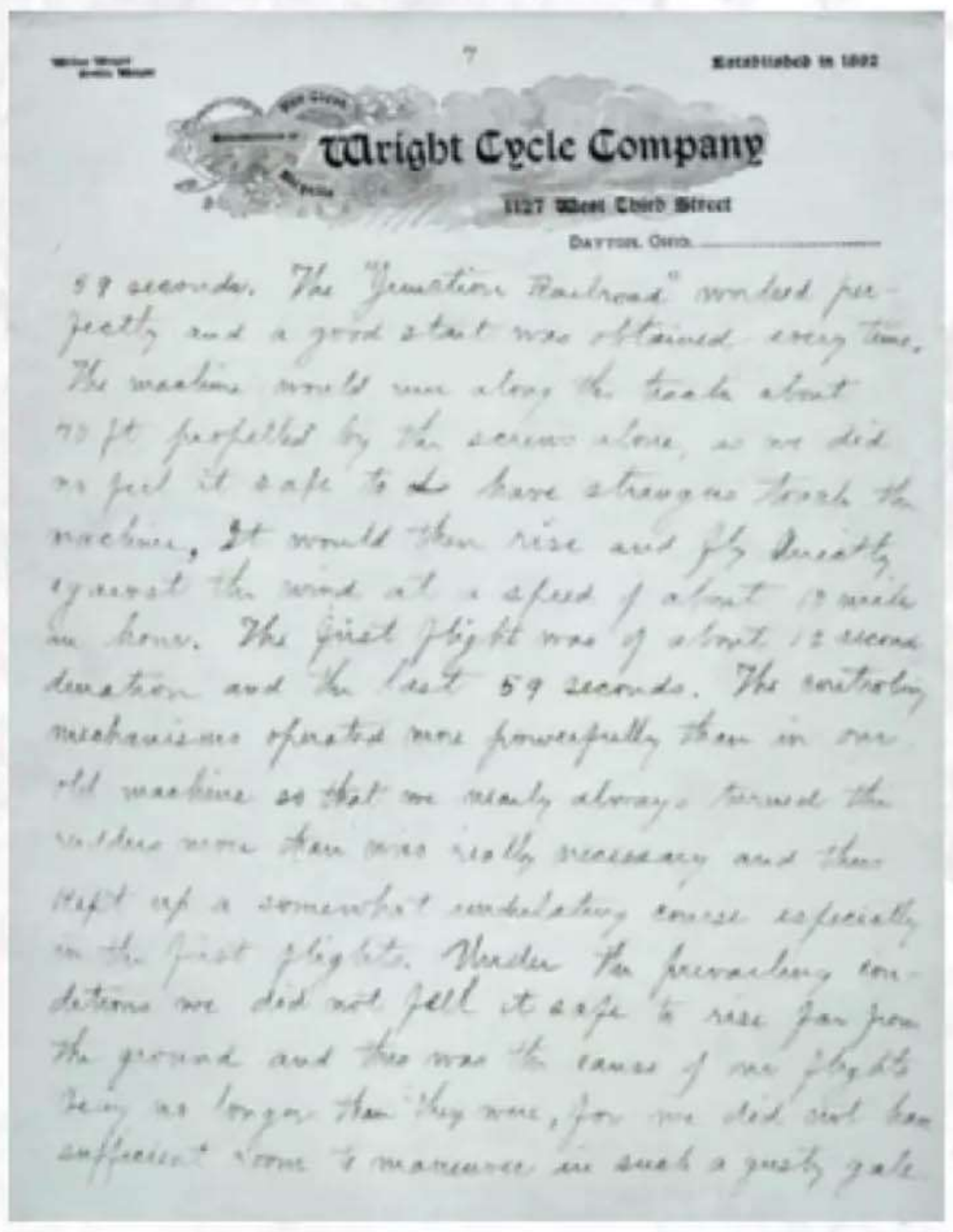
Established in 1892

Manufacturers of Van Cleve Bicycles
Wright Cycle Company
1127 West Third Street
DAYTON, OHIO.

vestigation which revealed the fact that one of the axles was giving way. Accordingly we removed both of them and Orville went home to make new ones. He was gone two weeks more, so that by the time every thing was ready again, five weeks had elapsed since the trouble with the axles began. We accordingly determined to try the machine at the earliest opportunity instead of waiting for the conditions we desired. So on the 14th inst although the wind was only 2 to 3 meters a second, thus making it necessary to use the hill in starting, we got the machine out and made the first trial. It rose from the track and soon reached a point as high as the starting point but as this was done too suddenly it lost speed somewhat so that it was no longer fully supported. In turning down to regain speed the rudder was moved too far, and the machine darted down and touched ground before it could be turned up again. The time was only 3½ seconds and the distance a little more than a hundred feet. The landing was made with the propellers still going, and with the machine sidling somewhat. The lower struts of the front rudder frame sunk into the sand and as it was braced only at the ends the





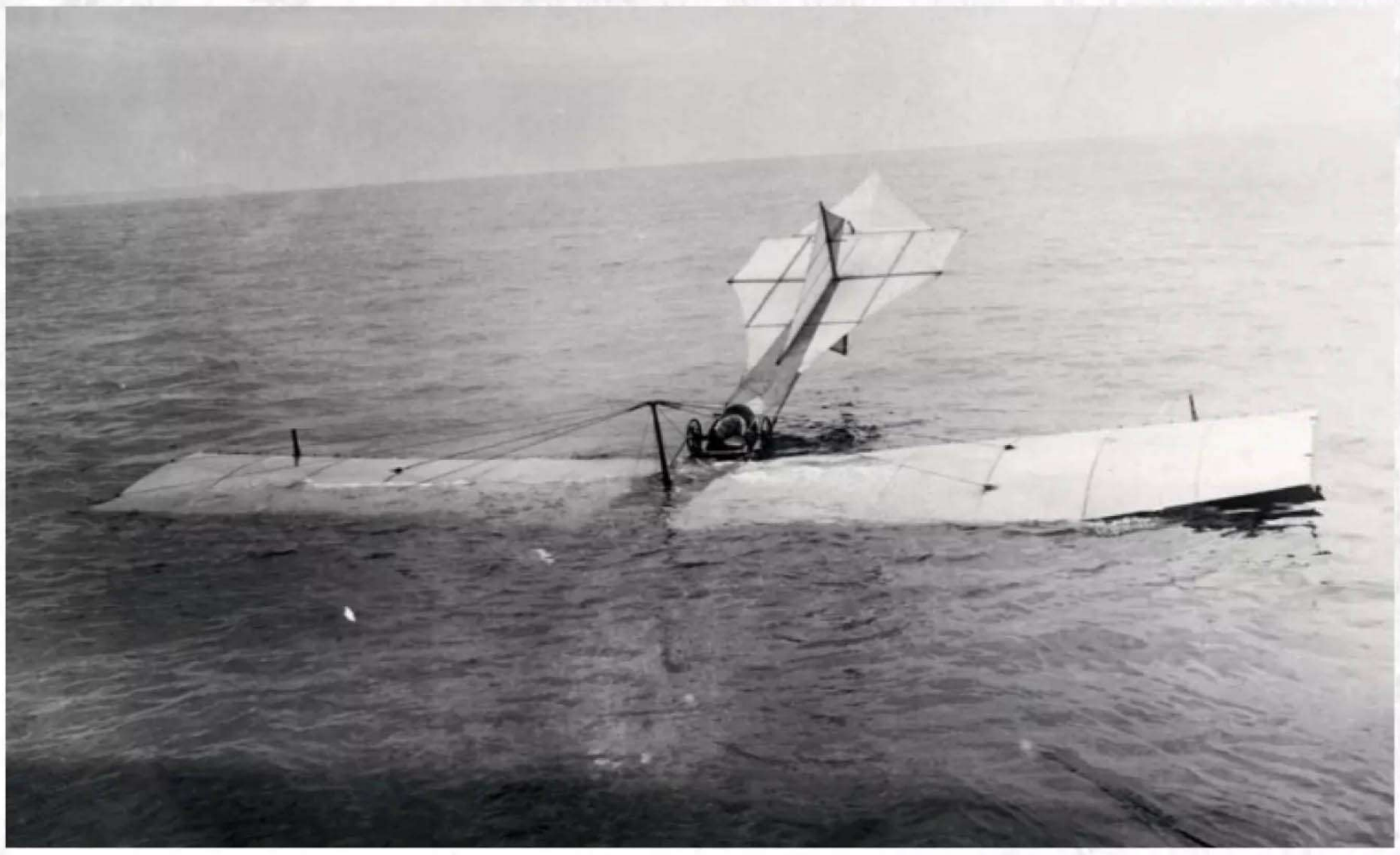


LOUIS BLÉRIOT: FIRST ENGLISH CHANNEL FLIGHT

Reports of the Wrights' achievements were treated with scepticism in Europe but pioneer aviators, particularly in France, were stirred into action by what they learnt of the brothers' aircraft. They were determined to do as well, if not better than the Americans, even though they were a long way behind. On 12 November 1906, Brazilian Alberto Santos-Dumont made the first powered heavier-than-air flight in Europe (220 metres/722 feet) at Bagatelle in Paris.

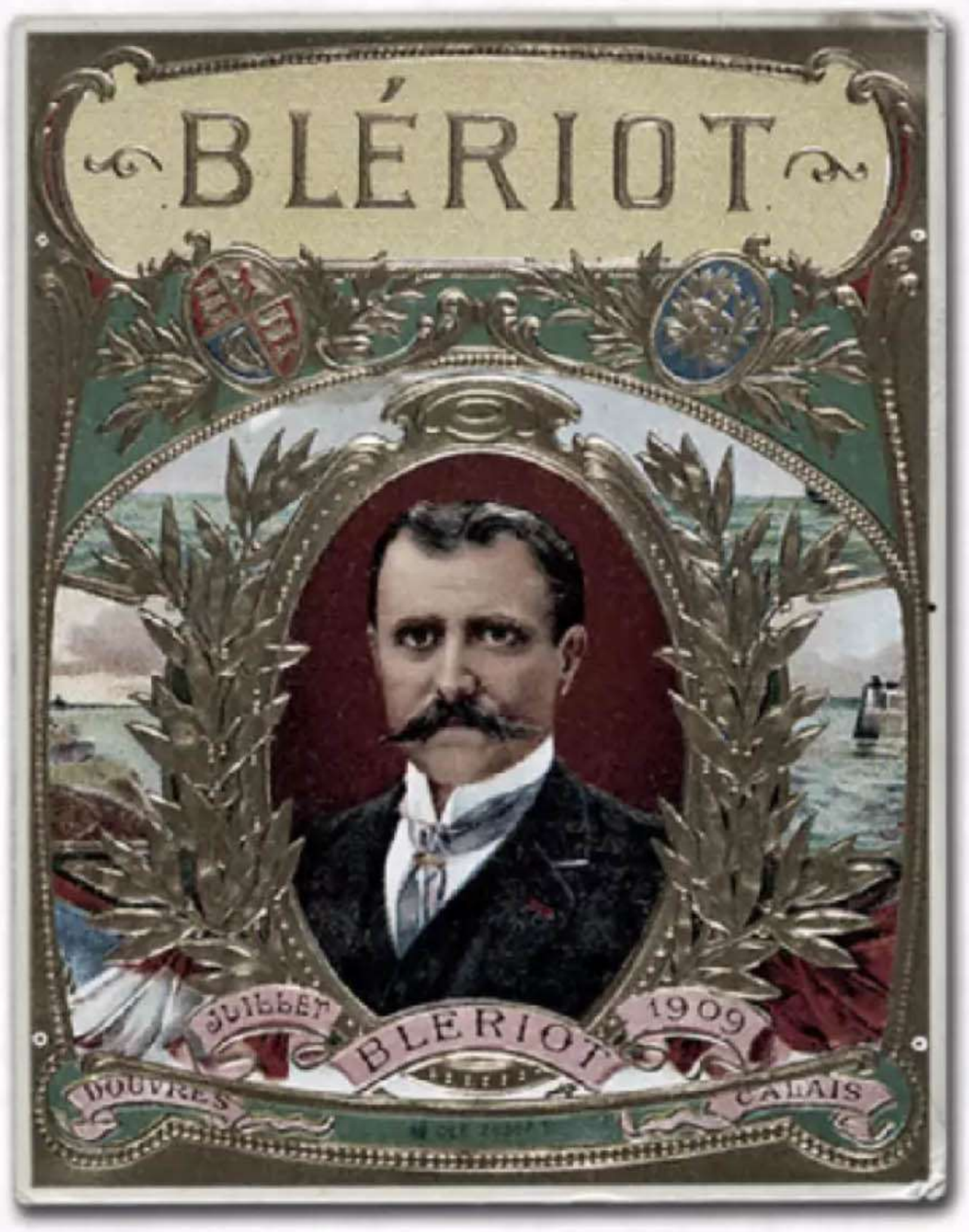
A year later, short flights were made by Louis Blériot and Robert Esnault-Pelterie in tractor (powered in front) biplanes. Real success came in 1908 with flights made in aircraft created by Gabriel Voisin and his younger brother Charles. These were biplanes with forward elevators and box kite-like tails but unlike the Wrights' Flyers, they lacked any means of lateral control. Despite this, Henri Farman won the Grand Prix d'Aviation by completing the first 1-kilometre (three-fifths-of-a-mile-) circular flight in Europe on 13 January 1908 in a modified Voisin.

To protect their designs the Wrights had ceased flying in 1905, but pushed by the success of their rivals and with deals secured to sell their machines, they decided to take to the air again. Wilbur Wright went to France where, on 8 August 1908, he demonstrated the Flyer at Hunaudiers racetrack to an astonished crowd. His complete control over the aircraft prompted the French newspaper Le Figaro to report, "There is no doubt Wilbur and Orville Wright have well and truly flown …". Wilbur further demonstrated the practicability of the



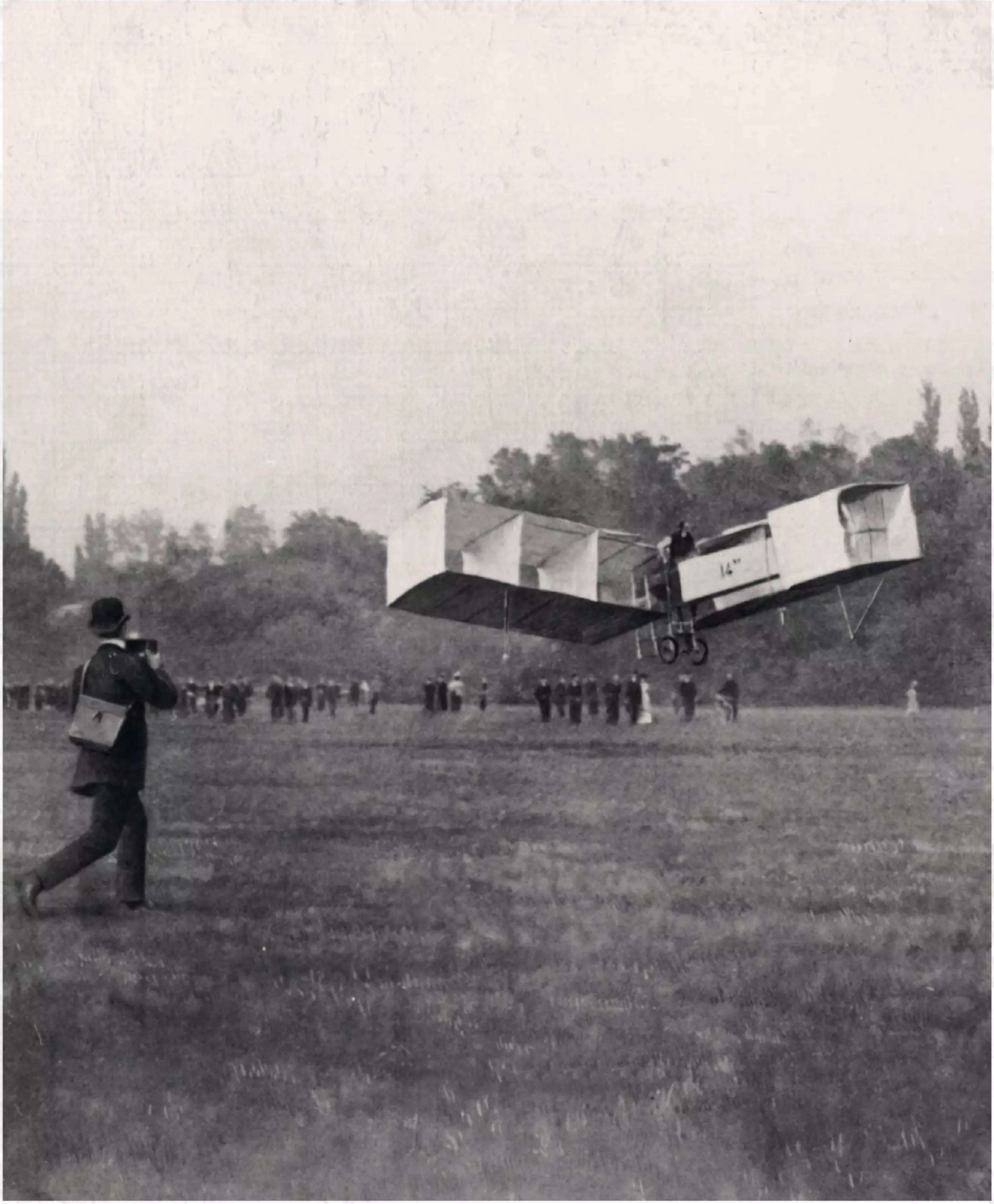
ABOVE: Hubert Latham made the first attempt to fly across the English Channel on 19 July 1909. He was forced to land on the sea when the engine of his Antoinette IV failed and was rescued by a French ship.

OPPOSITE: Alberto Santos-Dumont made the first powered heavier-than-air flight in Europe to exceed 25m (82ft) on 23 October 1906 in his 14-bis, a box-kit type aircraft, at Bagatelle, Paris. In 1907 he created the Demoiselle monoplane, the precursor of the modern light plane.



Louis Blériot
(1872–1936)

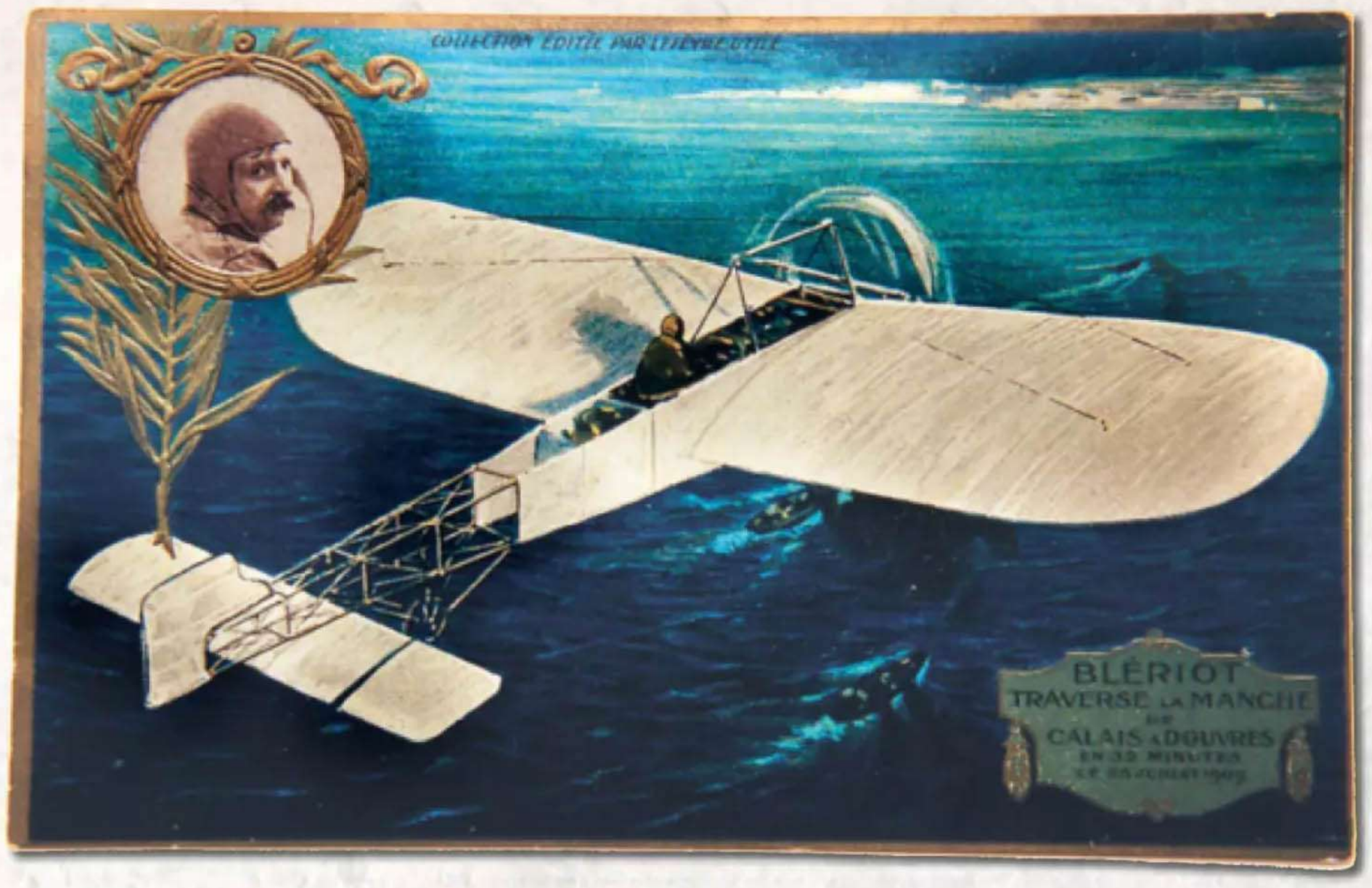
Louis Blériot was an engineer and businessman who made his money in motor car lights. He began to experiment with flying machines in 1900, developing his designs with Gabriel Voisin from 1903 to 1905 and solo from 1906. His first success came in 1907 with the Blériot VII monoplane that he flew for 500 metres (1,650 feet). He moved on to the Blériot XI in which he made the world's first flight over a large body of water (50 kilometres/31 miles) when he crossed the English Channel in 37 minutes on 25 July 1909. The flight created a huge demand for the Blériot XI and his company was soon the world's largest aircraft manufacturer. In 1914, Blériot became president of the SPAD company and turned it into one of France's leading manufacturers of combat aircraft. Blériot-Aeronautique switched to making commercial aircraft after the First World War.



14bis

Blériot XI monoplane

The Blériot XI was designed by Raymond Saulnier with input from Louis Blériot. With its front-mounted engine, tri-cycle undercarriage, front-mounted wings and rear-mounted tailplane, elevators and rudder, it established the basic aircraft shape still familiar to us today. The aircraft was powered by a 25-horsepower three-cylinder Anzani engine. Later versions had a 50-horsepower Gnome rotary engine. A weakness of early monoplanes was the stress placed on the externally braced wing. This led to them being replaced by biplanes. However some Blériot monoplanes were still flying at the start of the First World War.

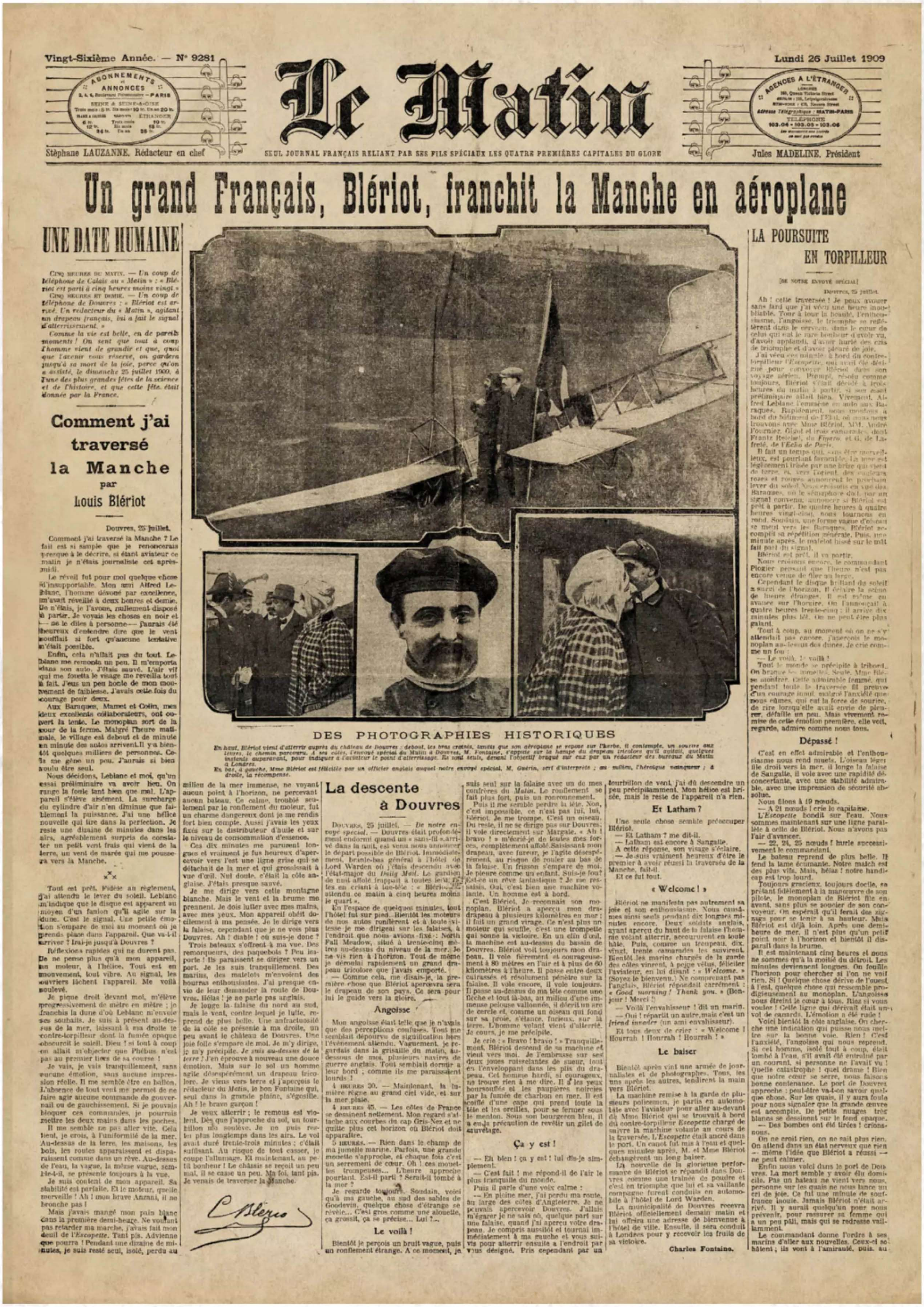


ABOVE: An illustration commemorating Blériot's successful crossing of the English Channel on 25 July 1909. Helped by the publicity surrounding the flight, the Blériot XI became the main product of Louis Blériot's aircraft company before the First World War and the foundation of its commercial success.

Wrights' aircraft with a series of flights ending in January 1909, spending a total of over 26 hours in the air, during which time he safely carried some 60 passengers. Among those who witnessed these flights was Louis Blériot. He realized that a new era in mechanical flight had commenced. Blériot, along with other French aviation pioneers, was quick to incorporate wing warping; a key part of the Wrights' means of control, into his latest aircraft, the Blériot XI.

Impressed by the public's enthusiasm for the Wrights and keen to promote aviation as well as his newspaper sales, Lord Northcliffe, owner of the British Daily Mail, offered a "£1,000 prize for the first flight in a heavier-than-air machine across the Channel". In July 1909, the press converged on the French coast near Calais, from where on a clear day, the white cliffs of Dover can be seen across the English Channel. Attention focused on two contenders for the prize, Louis Blériot in his Blériot XI and Hubert Latham. Latham made the first attempt in his Antoinette IV monoplane on 19 July. Unfortunately, its engine failed and Latham had to be rescued from the Channel by a French ship. After a period of bad weather, Blériot, who was

BELOW: Louis Blériot and his wife Alicia pose for the press in front of Blériot's aircraft near Dover Castle, the day after the cross Channel flight in July 1909.



Vingt-Sixième Année. — N° 9281

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Le Matin

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Lundi 26 Juillet 1909

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Un grand Français, Blériot, franchit la Manche en aéroplane

UNE DATE HUMAINE

Cinq heures du matin. — Un coup de téléphone de Calais au « Matin » : « Blériot est parti à cinq heures moins vingt. »

Cinq heures et demie. — Un coup de téléphone de Douvres : « Blériot est arrivé. Un rédacteur du « Matin », agitant un drapeau français, lui a fait le signal d'atterrissement. »

Comme la vie est belle, en de pareils moments ! On sent que tout à coup l'homme vient de grandir et que, quoi que l'avenir nous réserve, on gardera jusqu'à sa mort de la joie, parce qu'on a assisté, le dimanche 25 juillet 1909, à l'une des plus grandes fêtes de la science et de l'histoire, et que cette fête était donnée par la France.

Comment j'ai traversé la Manche

par

Louis Blériot

Douvres, 25 juillet.

Comment j'ai traversé la Manche ? Le fait est si simple que je renoncerais presque à le décrire, si étant aviateur ce matin je n'étais journaliste cet après-midi.

Le réveil fut pour moi quelque chose d'insupportable. Mon ami Alfred Leblanc, l'homme dévoué par excellence, m'avait réveillé à deux heures et demie. Je n'étais, je l'avoue, nullement disposé à partir. Je voyais les choses en noir et — ne le dites à personne — j'aurais été heureux d'entendre dire que le vent soufflait si fort qu'aucune tentative n'était possible.

Enfin, cela n'allait pas du tout. Leblanc me remonta un peu. Il m'emporta dans son auto. J'étais sauvé. L'air vif qui me fouetta le visage me réveilla tout à fait. J'eus un peu honte de mon mouvement de faiblesse. J'avais cette fois du courage pour deux.

Aux Baraques, Mamet et Colin, mes deux excellents collaborateurs, ont ouvert la tente. Le monoplan sort de la cour de la ferme. Malgré l'heure matinale, le village est debout et de minute en minute des autos arrivent. Il y a bientôt quelques milliers de personnes. Cela me gêne un peu. J'aurais si bien voulu être seul.

Nous décidons, Leblanc et moi, qu'un essai préliminaire va avoir lieu. On range la foule tant bien que mal. L'appareil s'élève aisément. La surcharge du cylindre d'air n'en diminue que faiblement la puissance. J'ai une hélice nouvelle qui tire dans la perfection. Je reste une dizaine de minutes dans les airs, agréablement surpris de constater un petit vent frais qui vient de la terre, un vent de marée qui me poussera vers la Manche.

⁂

Tout est prêt. Fidèle au règlement, j'ai attendu le lever du soleil. Leblanc m'indique que le disque est apparent au moyen d'un fanion qu'il agite sur la dune. C'est le signal. Une petite émotion s'empare de moi au moment où je prends place dans l'appareil. Que va-t-il arriver ? Irai-je jusqu'à Douvres ?

Réflexions rapides qui ne durent pas. Je ne pense plus qu'à mon appareil, au moteur, à l'hélice. Tout est en mouvement, tout vibre. Au signal, les ouvriers lâchent l'appareil. Me voilà soulevé.

Je pique droit devant moi, m'élève progressivement de mètre en mètre ; je franchis la dune d'où Leblanc m'envoie ses souhaits. Je suis à présent au-dessus de la mer, laissant à ma droite le contre-torpilleur dont la fumée opaque obscurcit le soleil. Dieu ! si tout à coup on allait m'objecter que Phébus n'est pas au premier tiers de sa course !

Je vais, je vais tranquillement, sans aucune émotion, sans aucune impression réelle. Il me semble être en ballon. L'absence de tout vent me permet de ne faire agir aucune commande de gouvernail ou de gauchissement. Si je pouvais bloquer ces commandes, je pourrais mettre les deux mains dans les poches.

Il me semble ne pas aller vite. Cela tient, je crois, à l'uniformité de la mer. Au-dessus de la terre, les maisons, les bois, les routes apparaissent et disparaissent comme dans un rêve. Au-dessus de l'eau, la vague, la même vague, semble-t-il, se présente toujours à la vue.

Je suis content de mon appareil. Sa stabilité est parfaite. Et le moteur, quelle merveille ! Ah ! mon brave Anzani, il ne bronche pas !

Mais j'avais mangé mon pain blanc dans la première demi-heure. Ne voulant pas retarder ma marche, j'avais fait mon deuil de l'*Escopette*. Tant pis. Advienne que pourra ! Pendant une dizaine de minutes, je suis resté seul, isolé, perdu au milieu de la mer immense, ne voyant aucun point à l'horizon, ne percevant aucun bateau. Ce calme, troublé seulement par le ronflement du moteur, fut un charme dangereux dont je me rendis fort bien compte. Aussi j'avais les yeux fixés sur le distributeur d'huile et sur le niveau de consommation d'essence.

Ces dix minutes me parurent longues et vraiment je fus heureux d'apercevoir vers l'est une ligne grise qui se détachait de la mer et qui grossissait à vue d'œil. Nul doute, c'était la côte anglaise. J'étais presque sauvé.

Je me dirige vers cette montagne blanche. Mais le vent et la brume me prennent. Je dois lutter avec mes mains, avec mes yeux. Mon appareil obéit docilement à ma pensée. Je le dirige vers la falaise, cependant que je ne vois plus Douvres. Ah ! diable ! où suis-je donc ?

Trois bateaux s'offrent à ma vue. Des remorqueurs, des paquebots ? Peu importe ! Ils paraissent se diriger vers un port. Je les suis tranquillement. Des marins, des matelots m'envoient des hourras enthousiastes. J'ai presque envie de leur demander la route de Douvres. Hélas ! je ne parle pas anglais.

Je longe la falaise du nord au sud, mais le vent, contre lequel je lutte, reprend de plus belle. Une anfractuosité de la côte se présente à ma droite, un peu avant le château de Douvres. Une joie folle s'empare de moi. Je m'y dirige, je m'y précipite. *Je suis au-dessus de la terre !* J'en éprouve à nouveau une douce émotion. Mais sur le sol un homme agite désespérément un drapeau tricolore. Je viens vers terre et j'aperçois le rédacteur du *Matin*, le bon Fontaine qui, seul dans la grande plaine, s'égosille. Ah ! le brave garçon !

Je veux atterrir ; le remous est violent. Dès que j'approche du sol, un tourbillon me soulève. Je ne puis rester plus longtemps dans les airs. Le vol avait duré trente-trois minutes ; c'était suffisant. Au risque de tout casser, je coupe l'allumage. Et maintenant, au petit bonheur ! Le châssis se reçoit un peu mal, il se casse un peu. Ma foi, tant pis. Je venais de traverser la Manche.

L. Blériot

DES PHOTOGRAPHIES HISTORIQUES

En haut, Blériot vient d'atterrir auprès du château de Douvres : debout, les bras croisés, tandis que son aéroplane se repose sur l'herbe, il contemple, un sourire aux lèvres, le chemin parcouru. A ses côtés, l'envoyé spécial du Matin à Douvres, M. Fontaine, s'appuie sur la hampe du drapeau tricolore qu'il agitait, quelques instants auparavant, pour indiquer à l'aviateur le point d'atterrissage. Ils sont seuls, devant l'objectif braqué sur eux par un rédacteur des bureaux du Matin à Londres.

En bas, à gauche, Mme Blériot est félicitée par un officier anglais auquel notre envoyé spécial, M. Guérin, sert d'interprète ; au milieu, l'héroïque vainqueur ; à droite, la récompense.

La descente à Douvres

Douvres, 25 juillet. — *De notre envoyé spécial.* — Douvres était profondément endormi quand un « sans-fil », arrivé dans la nuit, est venu nous annoncer le départ possible de Blériot. Immédiatement, branle-bas général à l'hôtel de Lord Warden où j'étais descendu avec l'état-major du *Daily Mail*. Le gardien de nuit affolé frappait à toutes les [illegible] en criant à tue-tête : « Blériot [illegible] attendu ce matin à cinq heures moins le quart ».

En l'espace de quelques minutes, tout l'hôtel fut sur pied. Bientôt les moteurs de nos autos ronflèrent et à toute vitesse je me dirigeai sur les falaises, à l'endroit que nous avions fixé : North Fall Meadow, situé à trente-cinq mètres au-dessus du niveau de la mer. Je ne vis rien à l'horizon. Tout de même je déroulai rapidement un grand drapeau tricolore que j'avais emporté.

— Comme cela, me disais-je, la première chose que Blériot apercevra sera le drapeau de son pays. Ce sera pour lui le guide vers la gloire.

Angoisse

Mon angoisse était telle que je n'avais que des perceptions confuses. Tout me semblait dépourvu de signification hors l'événement attendu. Vaguement, je regardais dans la grisaille du matin, au-dessous de moi, plusieurs navires de guerre anglais. Tout semblait dormir à leur bord ; comme ils me paraissaient lourds !

4 heures 30. — Maintenant, la lumière règne au grand ciel vide, et sur la mer plate.

4 heures 45. — Les côtes de France se dessinent nettement. Mon regard s'attache aux courbes du cap Gris-Nez et ne quitte plus cet horizon où Blériot doit apparaître.

5 heures. — Rien dans le champ de ma jumelle marine. Parfois, une grande mouette s'approche, et chaque fois c'est un serrement de cœur. Oh ! ces mouettes trompeuses... L'heure approche pourtant. Est-il parti ? Serait-il tombé à la mer ?

Je regarde toujours. Soudain, voici qu'à ma gauche, au sud des sables de Goodwin, quelque chose d'étrange se révèle... C'est gros comme une alouette, ça grossit, ça se précise... Lui ?...

Le voilà !

Bientôt je perçois un bruit vague, puis un ronflement étrange. A ce moment, je suis seul sur la falaise avec un de mes confrères du *Matin*. Le ronflement se fait plus fort, puis un ronronnement.

Puis il me semble perdre la tête. Non, c'est impossible, ce n'est pas lui, lui, Blériot. Je me trompe. C'est un oiseau. Du reste, il ne se dirige pas sur Douvres ; il vole directement sur Margate. « Ah ! bravo ! » m'écrié-je de toutes mes forces, complètement affolé. Saisissant mon drapeau, avec fureur, je l'agite désespérément, au risque de rouler au bas de la falaise. Un frisson s'empare de moi. Je pleure comme un enfant. Suis-je fou ? Est-ce un rêve fantastique ? Je me ressaisis. Oui, c'est bien une machine volante. Un homme est à bord.

C'est Blériot. Je reconnais son monoplan. Blériot a aperçu mon drapeau à plusieurs kilomètres en mer ; il fait un grand virage. Ce n'est plus un moteur qui souffle, c'est une trompette qui sonne la victoire. En un clin d'œil, la machine est au-dessus du bassin de Douvres. Blériot voit toujours mon drapeau. Il vole fièrement et courageusement à 80 mètres en l'air et à plus de 60 kilomètres à l'heure. Il passe entre deux cuirassés et résolument pénètre sur la falaise. Il vole encore, il vole toujours. Il passe au-dessus de ma tête comme une flèche et tout là-bas, au milieu d'une immense pelouse vallonnée, il décrit un arc de cercle et, comme un oiseau qui fond sur sa proie, s'élance, furieux, sur la terre. L'homme volant vient d'atterrir. Je cours, je me précipite.

Je crie : « Bravo ! bravo ! » Tranquillement, Blériot descend de sa machine et vient vers moi. Je l'embrasse sur ses deux joues ruisselantes de sueur, tout en l'enveloppant dans les plis du drapeau. Cet homme hardi, si courageux, ne trouve rien à me dire. Il a les yeux boursouflés et les paupières noircies par la fumée de charbon en mer. Il est coiffé d'une cape qui prend toute la tête et les oreilles, pour se fermer sous le menton. Sous son bourgeron bleu, il a eu la précaution de revêtir un gilet de sauvetage.

Ça y est !

— Eh bien ! ça y est ! lui dis-je simplement.

— C'est fait ! me répond-il de l'air le plus tranquille du monde.

Puis il parle d'une voix calme :

— En pleine mer, j'ai perdu ma route, au large des côtes d'Angleterre. Je ne pouvais apercevoir Douvres. J'allais m'égarer je ne sais où, quelque part sur une falaise, quand j'ai aperçu votre drapeau. Je compris aussitôt et tournai immédiatement à ma gauche et vous suivis pour atterrir ensuite à l'endroit par vous désigné. Pris cependant par un tourbillon de vent, j'ai dû descendre un peu précipitamment. Mon hélice est brisée, mais le reste de l'appareil n'a rien.

Et Latham ?

Une seule chose semble préoccuper Blériot.

— Et Latham ? me dit-il.

— Latham est encore à Sangatte.

A cette réponse, son visage s'éclaire.

— Je suis vraiment heureux d'être le premier à avoir réussi la traversée de la Manche, fait-il.

Et ce fut tout.

« Welcome ! »

Blériot ne manifesta pas autrement sa joie et son enthousiasme. Nous causâmes ainsi seuls pendant dix longues minutes encore. Deux soldats anglais, ayant aperçu du haut de la falaise l'homme volant atterrir, accoururent en toute hâte. Puis, comme un troupeau, dix, vingt, trente camarades les suivirent. Bientôt les marins chargés de la garde des côtes vinrent, à peine vêtus, féliciter l'aviateur, en lui disant : « *Welcome.* » (Soyez le bienvenu.) Ne comprenant pas l'anglais, Blériot répondait carrément : « *Good morning ! Thank you.* » (Bonjour ! Merci !)

— Voilà l'envahisseur ! dit un marin.

— Oui ! repartit un autre, mais c'est un *friend invader* (un ami envahisseur).

Et tous deux de crier : « Welcome ! Hourrah ! Hourrah ! Hourrah ! »

Le baiser

Bientôt après vint une armée de journalistes et de photographes. Tous, les uns après les autres, tendirent la main vers Blériot.

La machine remise à la garde de plusieurs policemen, je partis en automobile avec l'aviateur pour aller au-devant de Mme Blériot qui se trouvait à bord du contre-torpilleur *Escopette* chargé de suivre la machine volante au cours de la traversée. L'*Escopette* était ancré dans le port. Un canot fut mis à l'eau et quelques minutes après, M. et Mme Blériot échangèrent un long baiser.

La nouvelle de la glorieuse performance de Blériot se répandit dans Douvres comme une traînée de poudre et c'est en triomphe que lui et sa vaillante compagne furent conduits en automobile à l'hôtel de Lord Warden.

La municipalité de Douvres recevra Blériot officiellement demain matin et lui offrira une adresse de bienvenue à l'hôtel de ville. Ensuite, il sera conduit à Londres pour y recevoir les fruits de sa victoire.

Charles Fontaine.

LA POURSUITE EN TORPILLEUR

[De notre envoyé spécial]

Douvres, 25 juillet.

Ah ! cette traversée ! Je peux avouer sans fard que j'ai vécu une heure inoubliable. Tour à tour la beauté, l'enthousiasme, l'angoisse, le triomphe se reflétèrent dans le cerveau, dans le cœur de celui qui eut le rare bonheur d'avoir vu, d'avoir applaudi, d'avoir hurlé des cris de triomphe et d'avoir pleuré de joie.

J'ai vécu ces minutes à bord du contre-torpilleur l'*Escopette*, qui avait été désigné pour convoyer Blériot dans son voyage aérien. Prompt, résolu comme toujours, Blériot s'était décidé à trois heures du matin à partir, si son essai préliminaire allait bien. Vivement, Alfred Leblanc l'emmène en auto aux Baraques. Rapidement, nous montons à bord du bâtiment de l'État, où nous nous trouvons avec Mme Blériot, MM. André Fournier, Gizot et trois camarades, dont Frantz Reichel, du *Figaro*, et G. de Lafreté, de l'*Écho de Paris*.

Il fait un temps qui, sans être merveilleux, est pourtant favorable. La mer est légèrement irisée par une brise qui vient de terre, et, vers l'orient, des couleurs roses et rouges annoncent le prochain lever du soleil. Nous croisons en vue des Baraques, où le sémaphore doit, par un signal convenu, annoncer si Blériot est prêt à partir. De quatre heures à quatre heures vingt-cinq, nous tournons en rond. Soudain, une forme vague d'oiseau se meut vers les Baraques. Blériot accomplit sa répétition générale. Puis, une minute après, le matelot hissé sur le mât fait part du signal.

Blériot est prêt, il va partir.

Nous croisons encore, le commandant Piogier pensant que l'heure n'est pas encore venue de filer au large.

Cependant le disque brillant du soleil a surgi de l'horizon. Il éclaire la scène de lueurs étranges. Il est même en avance sur l'horaire. On l'annonçait à quatre heures trente-cinq ; il arrive dix minutes plus tôt. On ne peut être plus galant.

Tout à coup, au moment où on ne s'y attendait pas encore, j'aperçois le monoplan au-dessus des dunes. Je crie comme un fou :

— Le voilà, le voilà !

Tout le monde se précipite à tribord. On braque les jumelles. Seule, Mme Blé- [illegible] se montrer. Cette admirable femme, qui pendant toute la traversée fit preuve d'un courage inouï, malgré l'anxiété que nous eûmes, qui eut la force de sourire, de rire lorsqu'elle avait envie de pleurer, défaille un peu. Mais vivement remise de cette émotion première, elle voit, regarde, admire comme nous tous.

Dépassé !

C'est en effet admirable et l'enthousiasme nous rend muets. L'oiseau léger file droit vers la mer, il longe la falaise de Sangatte, il vole avec une rapidité déconcertante, avec une stabilité admirable, avec une impression de sécurité absolue.

Nous filons à 19 nœuds.

— A 21 nœuds ! crie le capitaine.

L'*Escopette* bondit sur l'eau. Nous sommes maintenant sur une ligne parallèle à celle de Blériot. Nous n'avons pas l'air d'avancer.

— 22, 24, 25 nœuds ! hurle successivement le commandant.

Le bateau reprend de plus belle. Il fend la lame écumante. Notre match est des plus vifs. Mais, hélas ! notre handicap est trop lourd.

Toujours gracieux, toujours docile, se prêtant fidèlement à la manœuvre de son pilote, le monoplan de Blériot file en avant, sans plus se soucier de son convoyeur. On espérait qu'il ferait des zigzags pour se tenir à sa hauteur. Mais Blériot est déjà loin. Après une demi-heure de mer, il n'est plus qu'un petit point noir à l'horizon et bientôt il disparaît dans la brume.

Il est maintenant cinq heures et nous ne sommes qu'à la moitié du détroit. Les minutes deviennent longues. On fouille l'horizon pour chercher si l'on ne voit rien. Si ! Quelque chose dérive de l'ouest à l'est, quelque chose qui ressemble prodigieusement au monoplan. L'angoisse nous étreint le cœur à tous. Riez si vous voulez ! Cette ligne qui dérivait était un vol de canards. L'émotion a été rude !

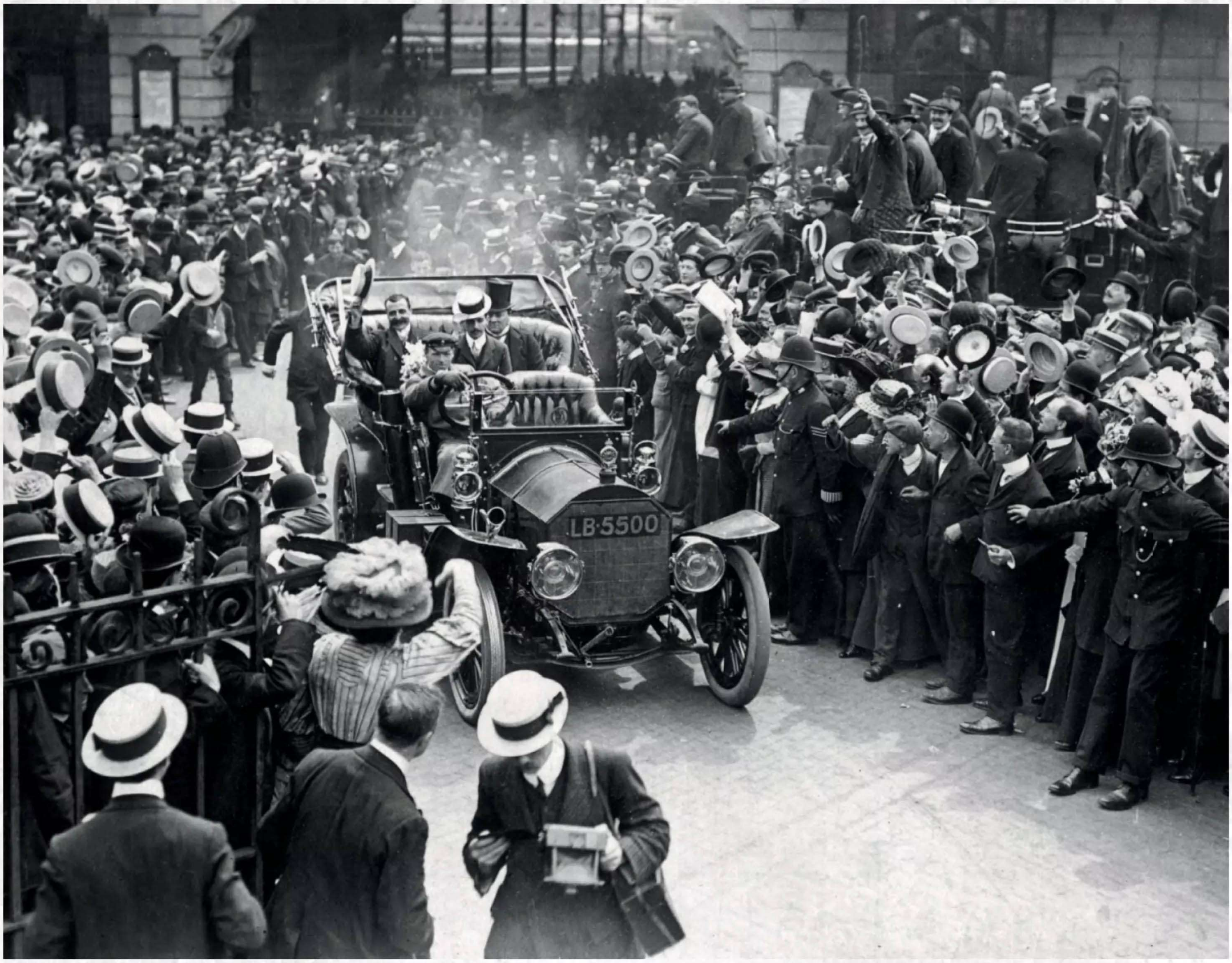
Voici bientôt la côte anglaise. On cherche une indication qui puisse nous mettre sur la bonne voie. Rien ! C'est l'anxiété, l'angoisse qui nous reprend. Si cet homme, isolé tout à coup, était tombé à l'eau, s'il avait été entraîné par un courant, si personne ne l'avait vu ! Quelle catastrophe ! quel drame ! Rien que notre cœur se serre, nous faisons bonne contenance. Le port de Douvres approche ; peut-être va-t-on savoir quelque chose. Sur les quais, il y aura foule pour nous signaler que la grande œuvre est accomplie. De petits nuages très blancs se dessinent sur le fond opaque.

— Des bombes ont été tirées ! crions-nous.

On ne croit rien, on ne sait plus rien. On attend dans un état nerveux que rien — même l'idée que Blériot a réussi — ne peut calmer.

Enfin nous voici dans le port de Douvres. La mort semble y avoir élu domicile. Pas un bateau ne vient vers nous, personne sur les quais ne nous lance un cri de joie. Ce fut une minute de souffrance inouïe. Jamais Blériot n'était arrivé. Il y aurait quelqu'un pour nous prévenir, pour rassurer sa femme qui a un peu pâli, mais qui se redresse vaillamment.

Le commandant donne l'ordre à ses marins d'aller aux nouvelles. Ceux-ci se hâtent ; ils vont à l'amirauté, puis, au

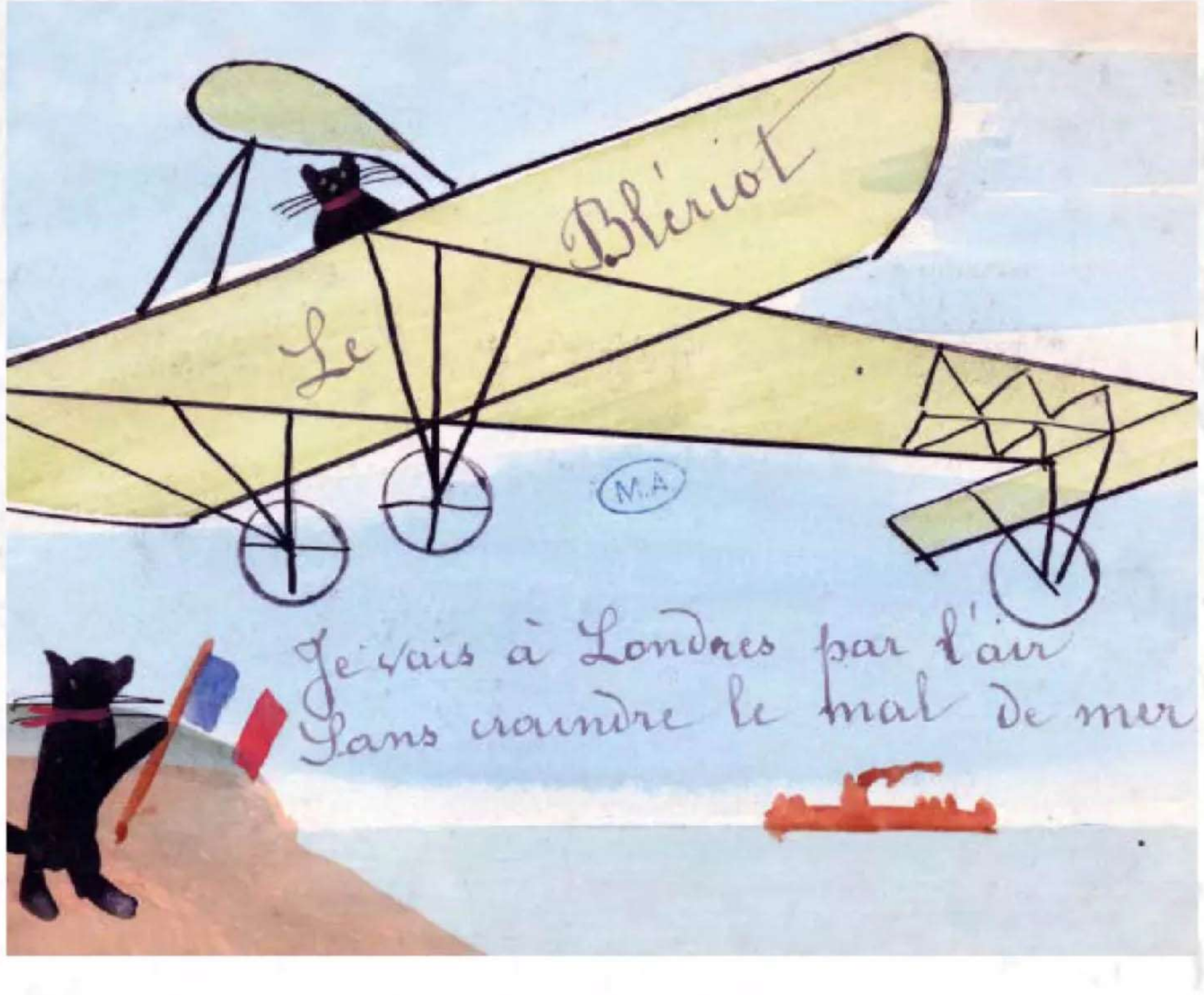


suffering from a burnt foot from a previous flight, courageously decided to make his attempt early in the morning of 25 July. He soon overtook a French destroyer escort and after ten minutes realized that as he checked his direction, he could not see the ship, France or England. Pressing on, Blériot glimpsed the English coast, headed for it and, caught by a gust of wind, made a crash landing in a field above the cliffs at Dover. Uninjured, Blériot's place in history was assured. He had made the world's first flight over a large body of water, some 36.5 kilometres (23.5 miles), which he crossed in a little over 37 minutes. But for the British this accomplishment brought with it the realization that the Channel no longer gave them the same security that they had previously enjoyed.

ABOVE: Louis Blériot acknowledges the applause of crowds in London on 26 July 1909 while on his way to meet Lord Northcliffe to accept the prize for the first flight across the Channel. Blériot also received a hero's welcome on his return to Paris a few days later.

OPPOSITE: Front cover of newspaper Le Matin celebrating Blériot's Channel flight, Monday 26 July 1909. The headline reads "A great Frenchman, Blériot, crosses the Channel in an aeroplane". It uses the French term for the Channel - La Manche, meaning "sleeve".

RIGHT: Postcard produced after Blériot's flight, it reads "I'm going to London by air so I won't be sea-sick".

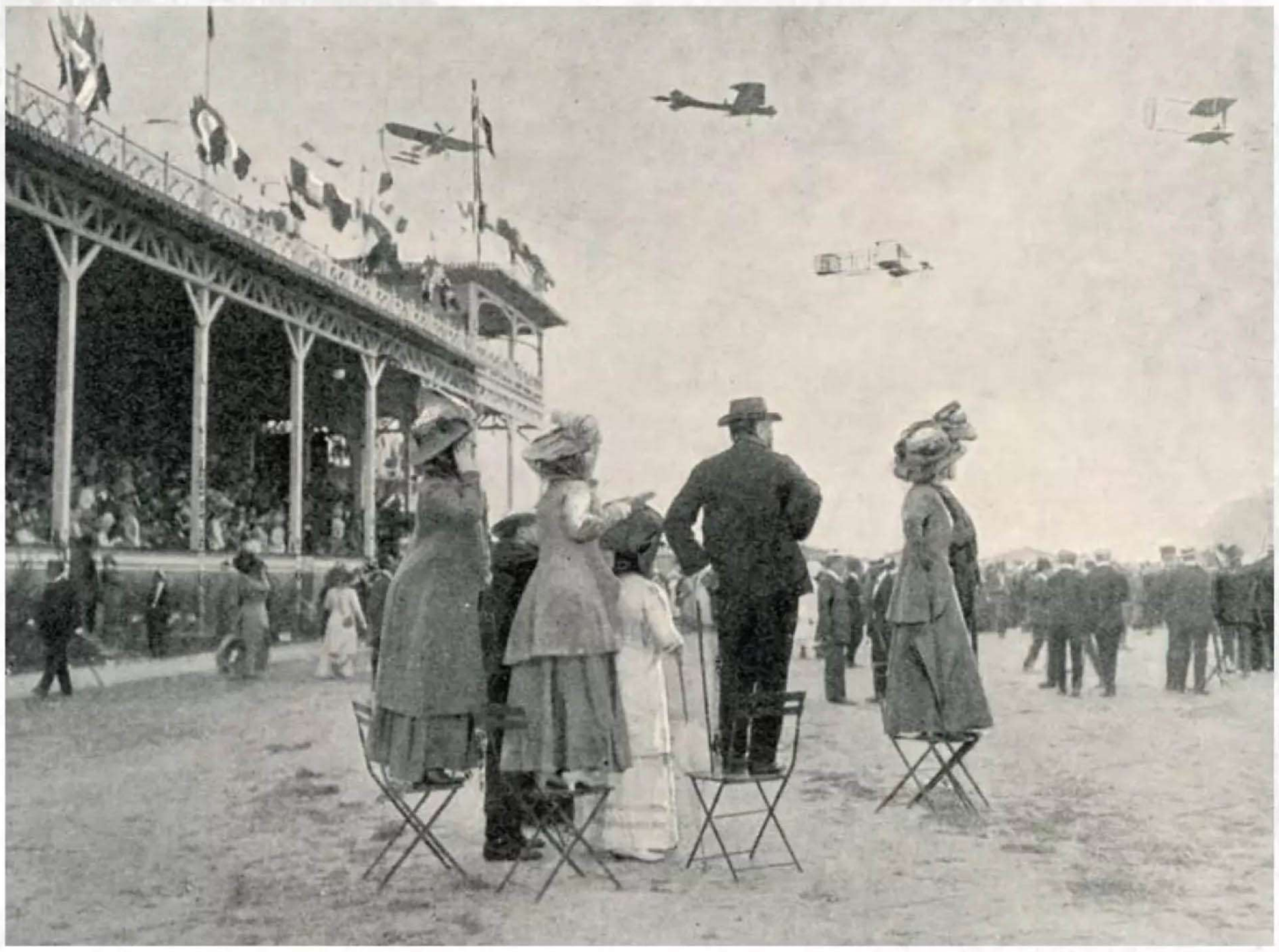

Le Blériot
M.A
Je vais à Londres par l'air
Sans craindre le mal de mer

THE BELLE EPOQUE

The world's first major aviation meeting, the Grande Semaine d'Aviation de la Champagne, was held in France near Reims between 22 and–29 August 1909. It attracted a crowd of nearly 200,000 spectators and firmly established aviation as a viable technology. Interest focused on three competitions, distance, speed and altitude. The distance competition was won by Henri Farman who flew a record 180 kilometres (112 miles). The prize for highest speed over a distance of 30 kilometres (19 miles) was won by American Glen Curtiss at an average speed of 75 kilometres per hour (47 miles per hour). Louis Blériot was a close second. Hubert Latham won the altitude contest by flying to an unprecedented 155 metres (508 feet).

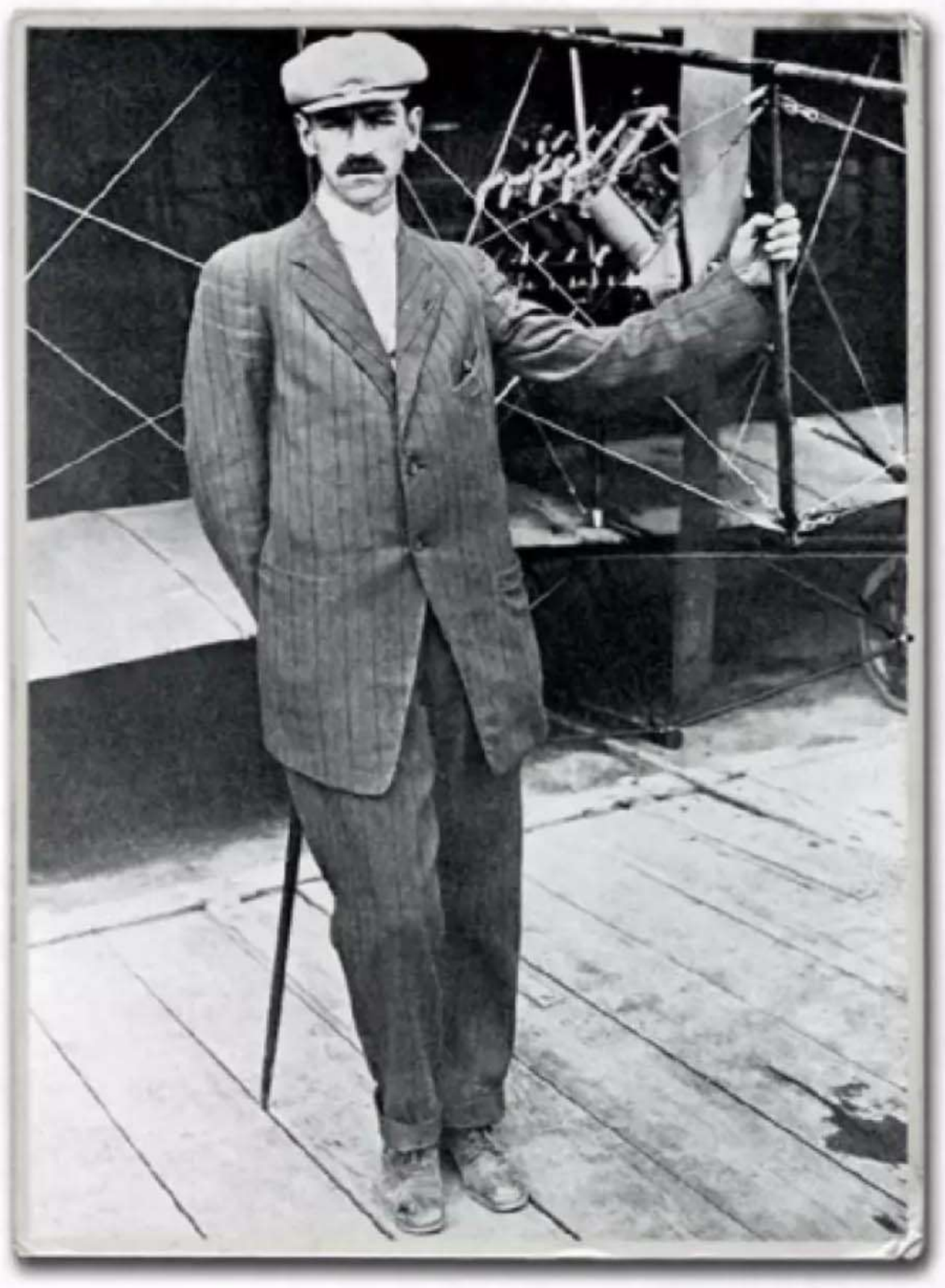
Reims set the pattern for the many air meetings that followed across Europe and the United States. Undoubtedly crashes were part of the attraction of these spectacles; 32 pilots, out of fewer than 600 worldwide, were killed in 1910. Crowds also came to expect more complex and dangerous flying. French pilot Adolphe Pégoud was the first to include the "loop the loop" stunt in his display in 1913, a year in which the French also dominated record and distance flying. Roland Garros made the first non-stop flight across the Mediterranean from France to Tunisia, Marcel Prévost set a new speed record of 204 kilometres per hour (126.7 miles per hour) and Edmond Perreyon, Blériot's chief test pilot, reached an altitude of 6,120 metres (20,079 feet).

In the United States, development moved at a slower pace. The Wright Brothers'



ABOVE: Spectators stand on chairs to get a better view of the aeroplanes during the Grande Semaine d'Aviation de la Champagne, near Reims, France in August 1909. The event was the precursor of many aviation meetings held in the years before the First World War.

OPPOSITE: Alliot Verdon Roe test flies the Roe II Triplane, the first product of the newly formed A V Roe and Company, in 1910. Later known as Avro, the company went on to become a major British aircraft manufacturer. In 1909 Roe had been the first to make a flight in an all-British aeroplane.



Glenn Curtiss

(1878–1930)

Glen Curtiss was a motorcycle manufacturer (he set a world motorcycle speed record of 219 kilometres per hour [136 miles per hour] in 1907) who moved into aviation after working with Alexander Graham Bell's Aerial Experiment Association. In 1908 their "June Bug" won the Scientific American Trophy for the first public flight in the US of more than one kilometre (0.6 miles). A Curtiss Model D made the first take-off from a ship in 1910. By 1914, Curtiss was the biggest aircraft manufacturer in the United States. The company produced 10,000 aircraft during the First World War, including the famous JN-4 trainer and flying boats.

aircraft company was set up in 1909 at Dayton, Ohio and their aeroplanes were made under licence by European companies, including Britain's Short Brothers. But the Wrights soon ceased to be market leaders as they became entangled in legal actions for infringements of their patents. Foremost of these was the case against Glen Curtiss which went on until 1914. Curtiss was a successful motorcycle manufacturer who turned to aviation in 1907 and who by 1914 was the leading aircraft manufacturer in the US. Exhausted by the litigation, Wilbur Wright died of typhoid fever in 1912 and Orville sold his interest in the Wright Company in 1915.

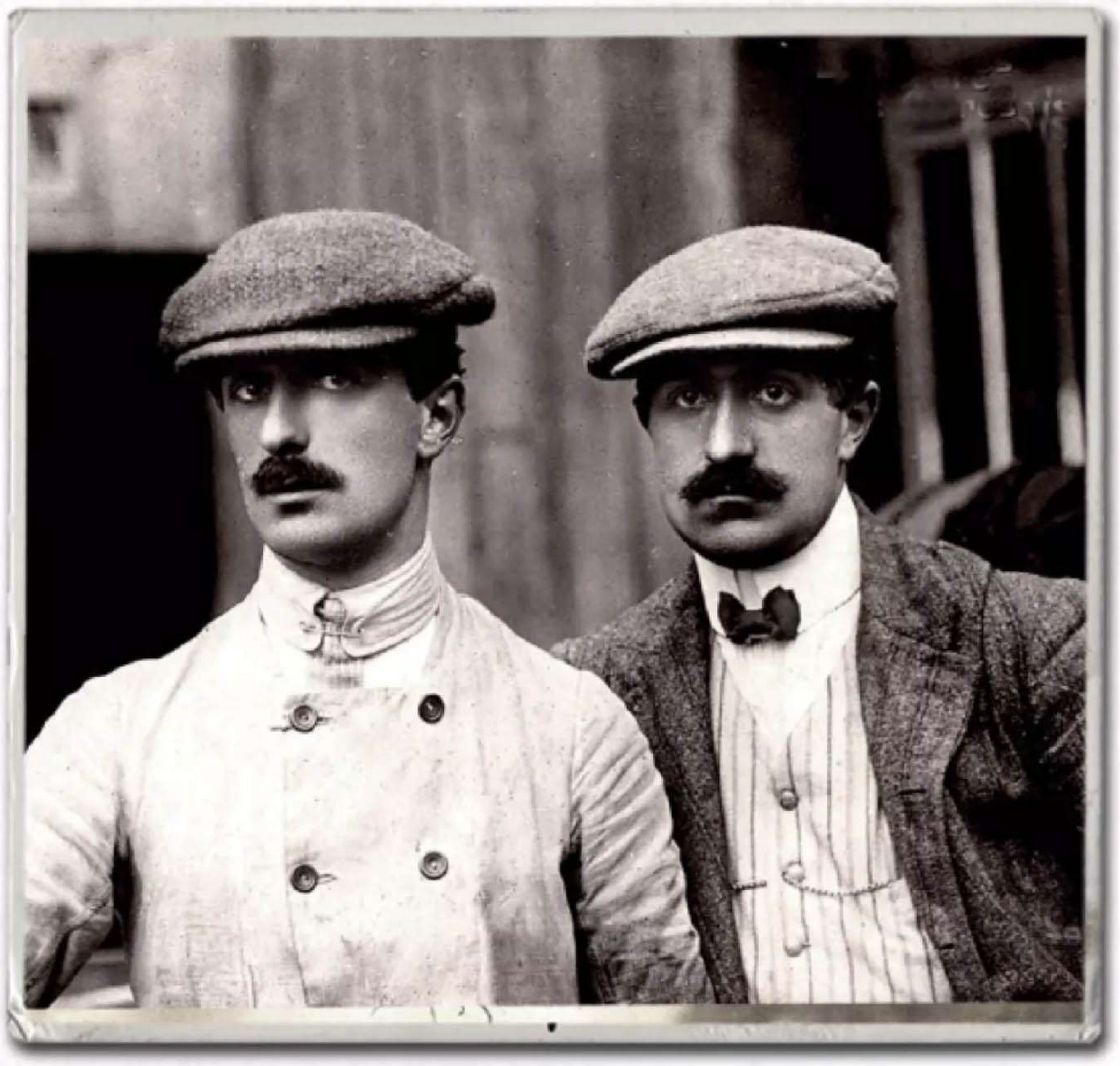
There was a steady expansion of aircraft types from 1909. The first flight from water was made by Henri Fabre in his seaplane, The Hydravia, in March 1910. In 1912, Glen Curtiss achieved another first by designing a

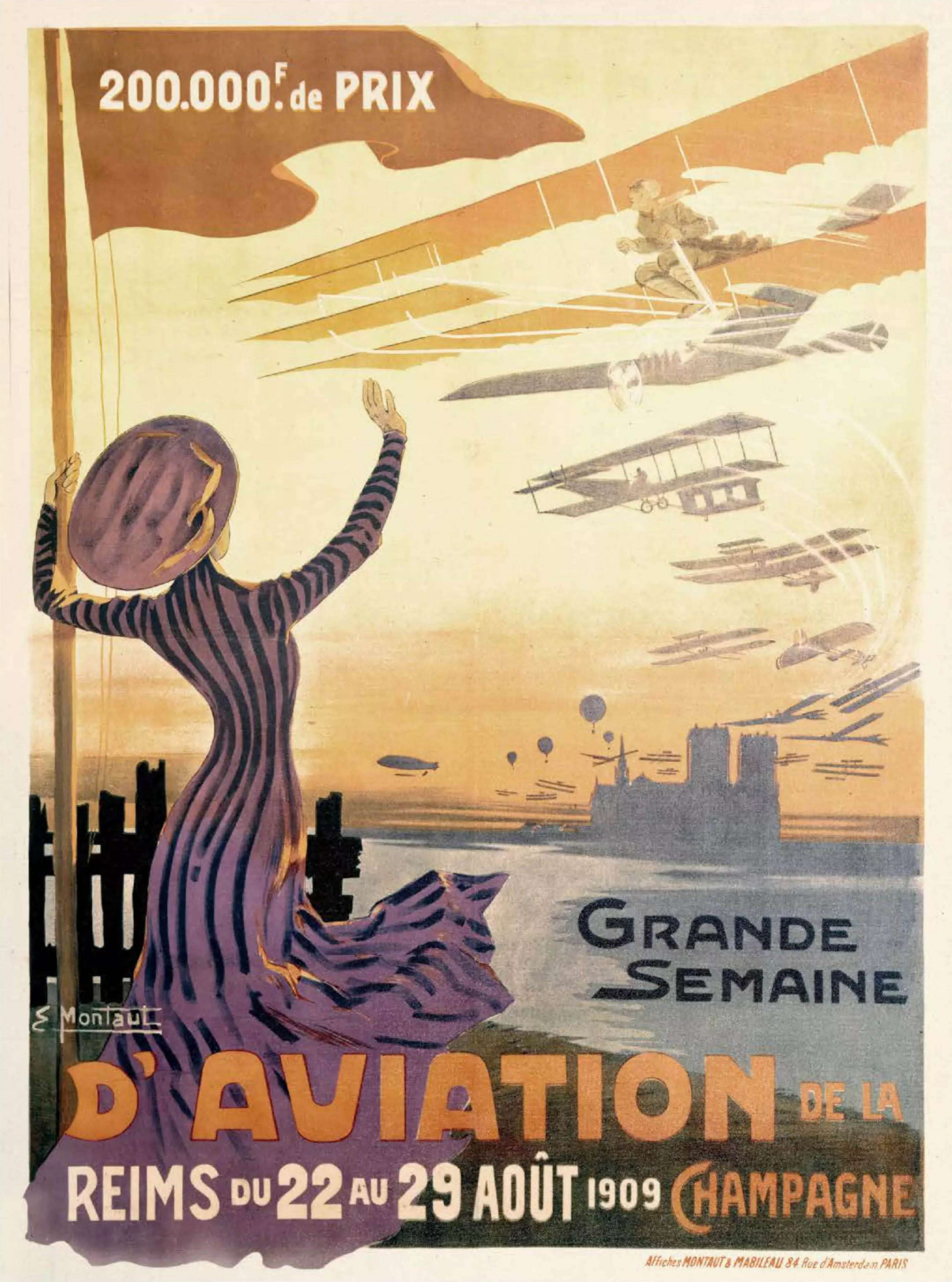
ABOVE: Pilot Harriet Quimby prepares to take off. In 1911 Quimby became the first licensed female pilot in the United States and in April of the following year, the first woman to fly across the English Channel. Only a few months later she died in a flying accident during a display at Boston Harbor in the US in July 1912.

BELOW: Cyclists standing on their bicycles peer over the perimeter fence to watch the 1911 Hendon aviation meeting. Under the leadership of Claude Grahame-White, Hendon became a major centre for aviation activity in Britain and after the First World War was best known for its annual RAF air displays.

Voisin Brothers

Gabriel Voisin (1880–1973) trained as an industrial designer. In 1900 he was hired as a designer for the Universal Exposition in Paris where he met Clément Ader, who sparked off his interest in aviation. He started experimenting with a glider in 1903–1904 and in 1905 began working with Louis Blériot. Their partnership ended in late 1906 and Gabriel and his brother Charles (1882–1912), then established Les Frères Voisin, one of the world's first aeroplane factories, at Billancourt, Paris. Their 1907 Voisin was used by many leading aviators, including Henri Farman. The company went on to produce over 10,000 aircraft by 1918.




200.000F. de PRIX
GRANDE
SEMAINE
D'AVIATION DE LA
REIMS DU 22 AU 29 AOÛT 1909 CHAMPAGNE
E. Montaut
Affiches MONTAUT & MABILEAU 84 Rue d'Amsterdam PARIS

flying boat, an aircraft with a boat-like hull. In Germany, aviation was dominated by the creations of Count Ferdinand von Zeppelin. His airships were large, steerable, powered, lighter-than-air, craft consisting of a rigid framework containing gas bags filled with hydrogen to provide lift.

By 1914 and the start of the First World War, Zeppelins had carried 37,000 passengers aloft. One flight, more than any other, demonstrated the potential of the aircraft. On 30 June 1914, pilot and designer Igor Sikorsky and three crew took off from St Petersburg in his large four-engined Il'ya Muromets for a successful 2,600-kilometre- (1,600-mile-) flight to Kiev and back. Sikorsky's design was adapted as a long-range bomber during the First World War, as were Zeppelin's airships.

The internationally tense years before 1914 saw the military take an increasing interest in the aeroplane. The French formed the Aéronautique Militaire in 1910 and the Imperial German Army Air Service was formed in the same year. The Russian Army Air Service was established in 1912 as was the British Royal Flying Corps (RFC). Initially, the RFC had a military and a naval wing but the separate Royal Naval Air Service (RNAS) was formed in 1914. The RFC and the RNAS subsequently joined together in 1918 to form the Royal Air Force (RAF). As the world slid towards war, the pioneer aircraft companies such as Voisin, Farman, Blériot, Breguet and Nieuport in France, Albatros, Rumpler, Aviatik and Fokker in Germany and Avro, Handley Page Sopwith and Bristol in Britain, began to expand and switch to large scale production.

ABOVE: The Sopwith Tabloid in which Briton Harold Pixton won the Schneider Trophy, a speed race for seaplanes, in April 1914 at Monaco, France. Pixton flew at an average speed of 139.4 kilometres per hour (86.6 miles per hour).

OPPOSITE: A lithograph poster by Ernest Montaut advertising the Grande Semaine d'Aviation de la Champagne which was held near Reims in August 1909. The event was sponsored by local champagne producers.

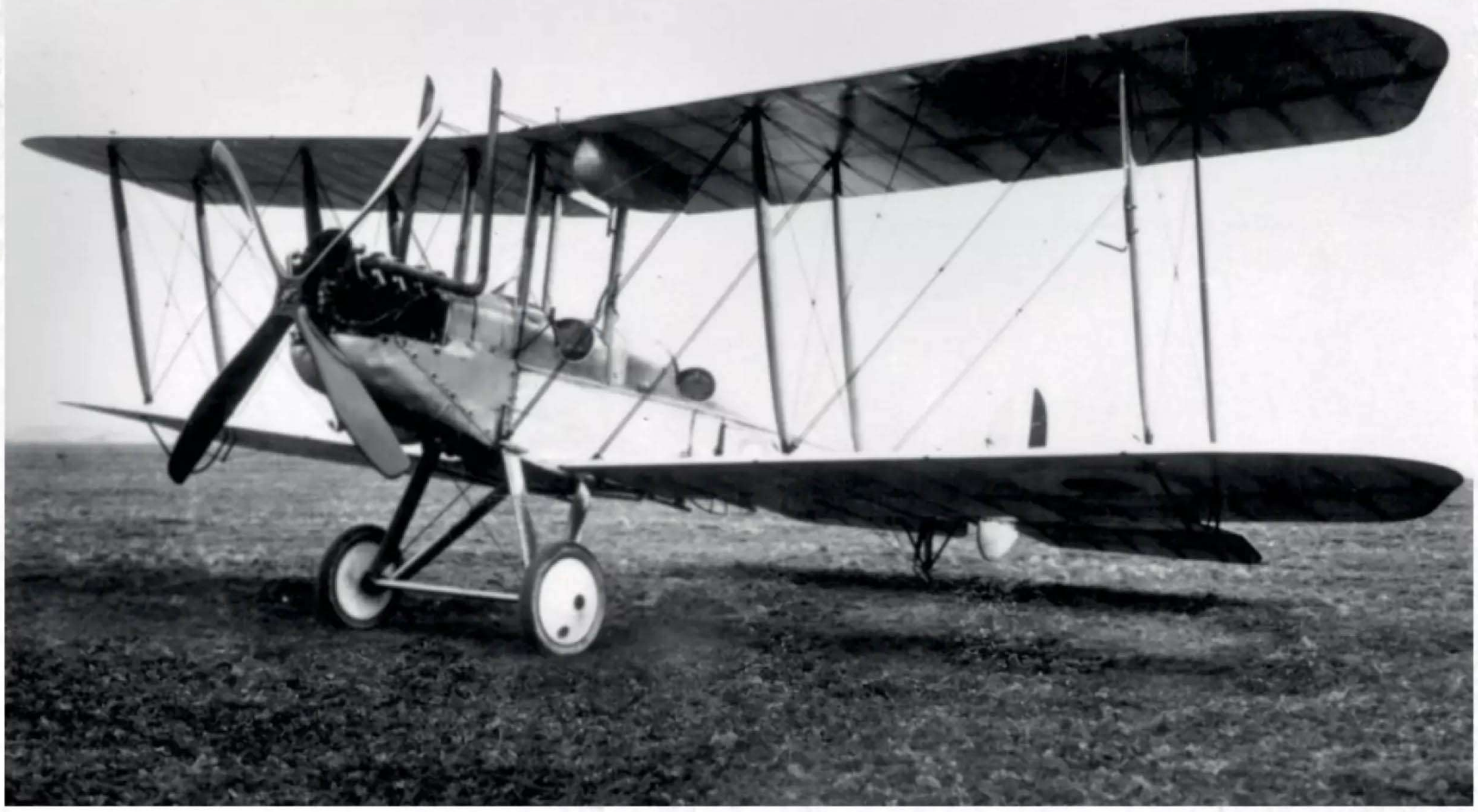
THE AEROPLANE GOES TO WAR

Military aviation was in its infancy when the European powers went to war in August 1914 at the start of what we now know as the First World War. However, by the end of the war in 1918, the air had joined the land and the sea as a place in which men fought and died, and from which attacks were launched on both military and civilian targets.

At the start of the war, the main combatant nations – Britain, France and Russia on the one side and Germany and Austro-Hungary on the other – could muster fewer than 500 serviceable aircraft for military or naval purposes. The military had one main use for these simple, initially unarmed and often unreliable biplanes and monoplanes – reconnaissance; finding out what the other side was doing. In this, aeroplanes were seen as an adjunct to the cavalry, the army's traditional scouting force, but as the conflict developed they soon came to replace it and

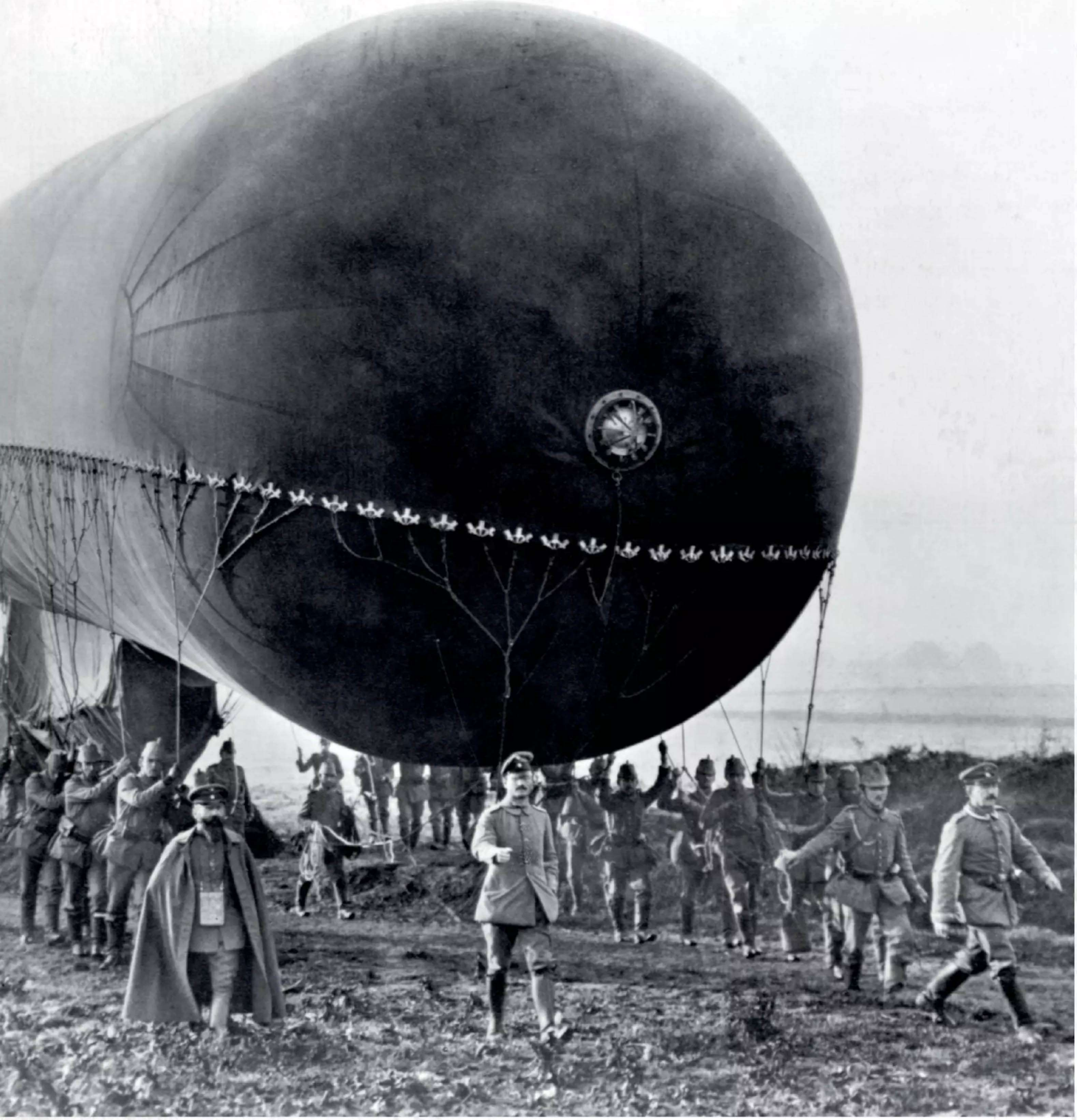
Royal Aircraft Factory
BE2c

The BE2 was designed before the war in 1912 at the Royal Aircraft Factory by Geoffrey de Havilland. It first flew in 1912, and at the time it out-performed its competitors, but by 1914 it was recognized that this unarmed and slow aircraft needed upgrading. The improved BE2c was very stable and this made the aircraft good for aerial reconnaissance work, but its slow speed and ineffective armament made it an easy target for enemy fighters. Industry was geared up to produce the BE2c in large numbers so it stayed in production far longer than it should have.



ABOVE: The BE2c was the first armed version of the Royal Aircraft Factory's BE2 reconnaissance aircraft. The machine gun was carried in the forward cockpit, greatly restricting the observer's field of fire.

RIGHT: A German balloon being manoeuvred into position. Both sides used tethered balloons as observation platforms. Balloons were not easy to attack from the air as they were heavily defended by batteries of guns on the ground but in case they were hit, the observers were equipped with parachutes. Aircraft pilots were not issued with parachutes until 1918, when German crews became the first to use them.



Geoffrey de Havilland
(1882–1965)

Geoffrey de Havilland was one of aviation's great design and manufacturing pioneers. He joined what was to become the Royal Aircraft Factory in 1910 and moved to the Aircraft Manufacturing Company (Airco) in 1914 to become its chief designer. Aircraft designed by de Havilland accounted for over 30 per cent of Allied aircraft and some 95 per cent of American wartime production. He set up the de Havilland Aircraft Company in 1920. Among its many products was the Moth series of light aeroplanes, the fast and versatile Second World War Mosquito and the Comet, the first jet airliner.

LEFT: rench cavalry watch an aeroplane passing overhead in 1914. Aircraft came to replace cavalry in its traditional role of scouting for the armies.

make a significant contribution of their own to the conduct of the war.

As the Germans advanced in Western Europe, the Allied armies were forced to retreat, but information gathered by aircraft helped them to halt the advance and launch counter-attacks that forced the invaders back. This war of movement ended when neither side could get around the other and both were forced to dig defensive trench lines that by the winter of 1914–1915 stretched from the English Channel to the Swiss border. For the next three-and-a half-years, as millions of soldiers became locked in the bitter relentless struggle of trench warfare, only observers in aeroplanes and tethered balloons could effectively see and record what was happening along and across the Western Front.

Reconnaissance aircraft such as the BE2c were generally two-seaters carrying a pilot and an observer. While the pilot concentrated on flying the aircraft, the observer gathered information. Initially this was recorded by sketches, but from 1915 photography became the principal aerial reconnaissance technique. Whole sections of the trenches could be photographed in great detail. These photographs were then joined together to form large "photo mosaics" which could be interpreted for essential information or intelligence that was used both to determine the enemy's intentions and to plan attacks against them.

A related task for aircraft and their crews was artillery spotting. Artillery barrages fired against defensive positions both preceded and continued throughout offensives. They never achieved a decisive effect, however, until the return to more mobile warfare during 1918, the last year of the war, when they were used in conjunction with other means of assault, including low flying, strafing and bombing aircraft. Aircraft observers could spot where artillery shells fell and with the introduction of effective wireless transmitters from 1915, could communicate target co-ordinates by Morse code to the gunners who then directed their fire accordingly.

Intelligence gathered through photo-reconnaissance had to be frequently updated so patrols were flown every day alongside regular artillery-spotting flights. Initially, the main threats faced by the aircraft crews came from the weather, fire from the ground, and the unreliability of their machines, but as they started to arm themselves; first of all with rifles or hand-thrown bombs and then machine-guns, the war in the air became far more dangerous. In 1914, the Allies probably held the upper hand but with the introduction of purpose-built fighter aircraft in 1915, the reconnaissance aircraft suffered as they flew on their steady patrol lines. Forty seven of the 80 aircraft destroyed by the German ace Manfred von Richthofen were engaged on reconnaissance duties!

AIR FIGHTING IN THE FIRST WORLD WAR

Fighter aircraft were developed to prevent or disrupt the work of reconnaissance and artillery-spotting aeroplanes over the Western Front. After 1915, they were generally single-seat aircraft armed with a machine-gun, or guns, that were aimed by pointing the fighter at the target. Once fighters began to appear in large numbers in 1916, each side attempted to stop the other from destroying their reconnaissance aircraft. This led to fighter combats and an ongoing battle to control the skies over the battlefields.

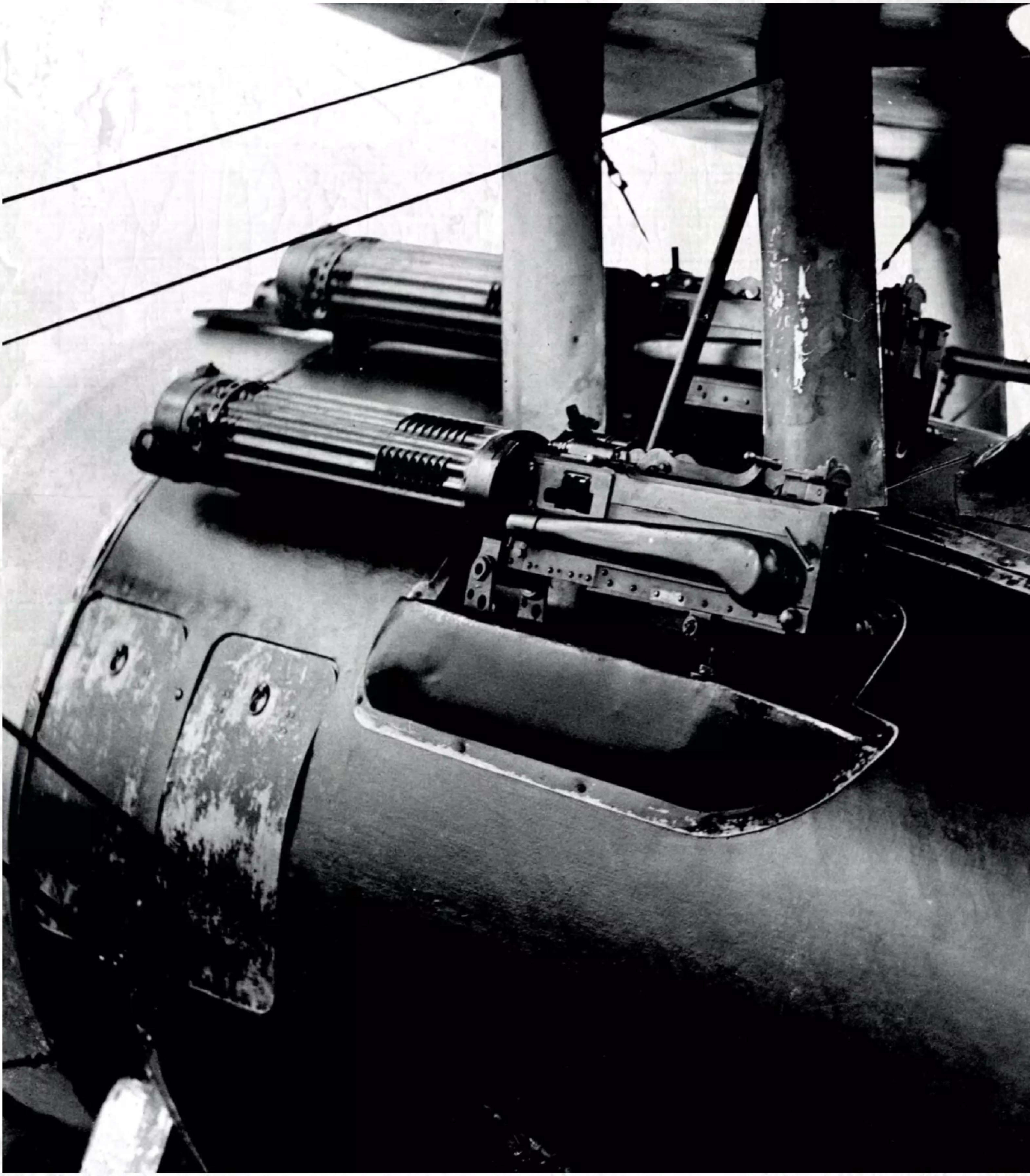
ABOVE: Successful pre-war aviator Roland Garros in June 1911. Garros joined the French air service at the outbreak of war and in April 1915 achieved the first-ever shooting-down of an aircraft in which a machine gun was fired through a propeller fitted with deflector plates. He shot down two more enemy aircraft before he too went down and both he and his aircraft were captured by the Germans.

RIGHT: A British Sopwith F 1 Camel. The Camel destroyed more German aircraft than any other Allied aircraft during the First World War. It could be difficult to fly but in the hands of a competent pilot the Camel proved a very manoeuvrable fighter.

Arming a fighter aircraft with a machine gun was not easy. The weapon had to be light and accessible to the pilot and this meant that it had to be mounted either above the engine and fired through the arc of the propeller or above the top wing of a biplane. The former was problematic as the bullets could hit the propeller. The French tried placing metal plates on the propeller to deflect bullets should they hit the blades but this was unreliable and very dangerous. Another alternative was to use a pusher type aircraft, in which the engine and propeller were mounted behind the pilot, leaving the field of fire forward clear. The Germans came up with the best solution when they fitted an interrupter mechanism to their Fokker Eindecker monoplane. This paused the machine gun when the propeller was in the line of fire. Using the Fokker, the Germans took control of the skies over their trenches during the winter of 1915–1916, shooting down so many Allied aircraft that British Royal Flying Corps (RFC) pilots referred to themselves as "Fokker Fodder".

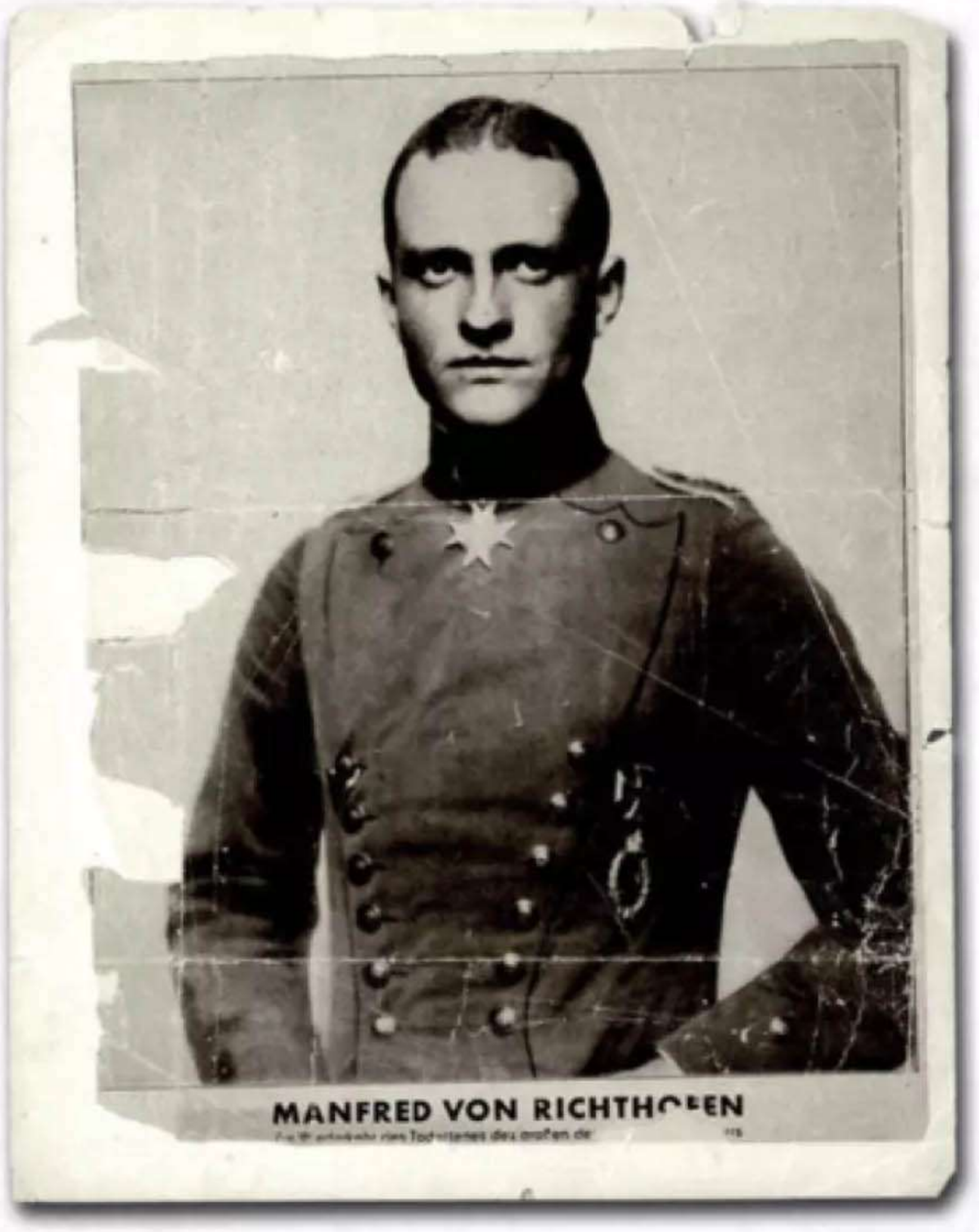
In preparation for their offensive against the French at Verdun in February 1916, the Germans formed specialist units of fighters and developed air-fighting tactics that took a growing toll on French machines. To regain the initiative, the French re-equipped their air units with the Nieuport Scout, whose gun was mounted on the aircraft's upper wing and concentrated their fighter squadrons into

N6254



ABOVE: Captain Albert Ball seated in the cockpit of a Royal Aircraft factory SE5a. With at least 44 victories to his credit, Ball was killed in May 1917 while flying with No 56 Squadron, RFC.

LEFT: Captain Edward V Rickenbacker of the United States air service. Rickenbacker scored 26 victories between April and November 1918 and was the leading American ace of the First World War.



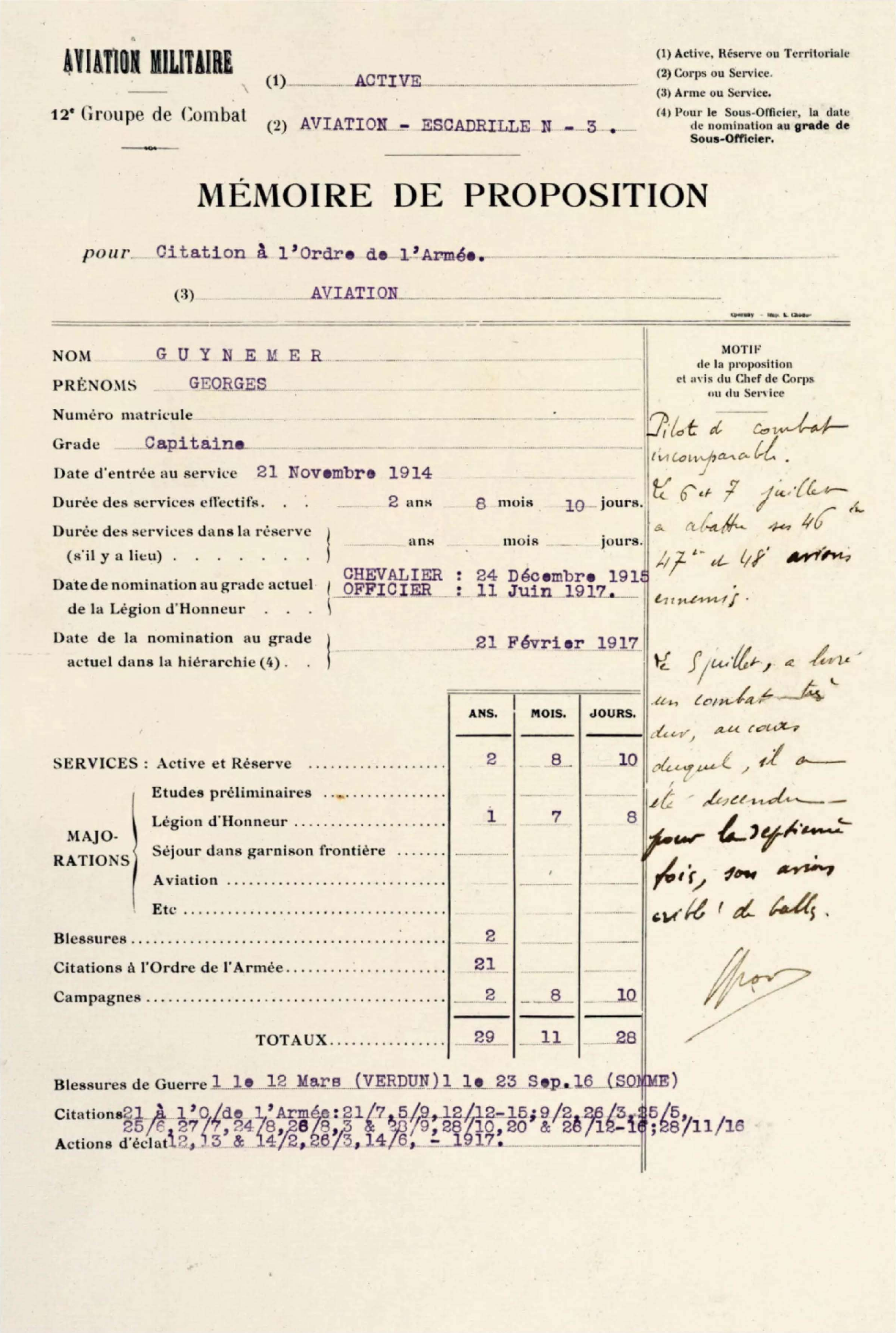
Manfred von Richthofen

(1892–1918)

With 80 victories to his name, Baron Manfred von Richthofen was the top-scoring fighter pilot of the First World War. He died on 21 April 1918 flying a red Fokker DrI Triplane. The RAF credited this as an aerial victory to Canadian Captain Roy Brown but there is considerable evidence to suggest that Richthofen was in reality killed by ground fire. The baron was a fine leader of the JG1 mobile unit, the famous "Flying Circus", but showed few signs of chivalry in combat, ruthlessly hunting down his victims. Today he is still remembered in popular culture as the Red Baron after the red colour of the aircraft he flew.

RIGHT: A note proposing a mention in Despatches for Captain Georges Guynemer following actions in July 1917 in which he scored his 46th, 47th and 48th victories.

OPPOSITE: A bi-lingual guide to aircraft recognition and insignia from the first half of the First World War.



AVIATION MILITAIRE

12e Groupe de Combat

(1) ACTIVE

(2) AVIATION - ESCADRILLE N - 3 .

(1) Active, Réserve ou Territoriale
(2) Corps ou Service.
(3) Arme ou Service.
(4) Pour le Sous-Officier, la date de nomination au **grade de Sous-Officier.**

MÉMOIRE DE PROPOSITION

pour Citation à l'Ordre de l'Armée.

(3) AVIATION

NOM GUYNEMER

PRÉNOMS GEORGES

Numéro matricule

Grade Capitaine

Date d'entrée au service 21 Novembre 1914

Durée des services effectifs . . . 2 ans 8 mois 10 jours.

Durée des services dans la réserve (s'il y a lieu) . . . . ans mois jours.

Date de nomination au grade actuel de la Légion d'Honneur . . . CHEVALIER : 24 Décembre 1915 / OFFICIER : 11 Juin 1917.

Date de la nomination au grade actuel dans la hiérarchie (4) . . 21 Février 1917

		ANS.	MOIS.	JOURS.
SERVICES : Active et Réserve		2	8	10
MAJORATIONS	Etudes préliminaires			
	Légion d'Honneur	1	7	8
	Séjour dans garnison frontière			
	Aviation			
	Etc			
Blessures		2		
Citations à l'Ordre de l'Armée		21		
Campagnes		2	8	10
TOTAUX		29	11	28

Blessures de Guerre 1 le 12 Mars (VERDUN) 1 le 23 Sep.16 (SOMME)

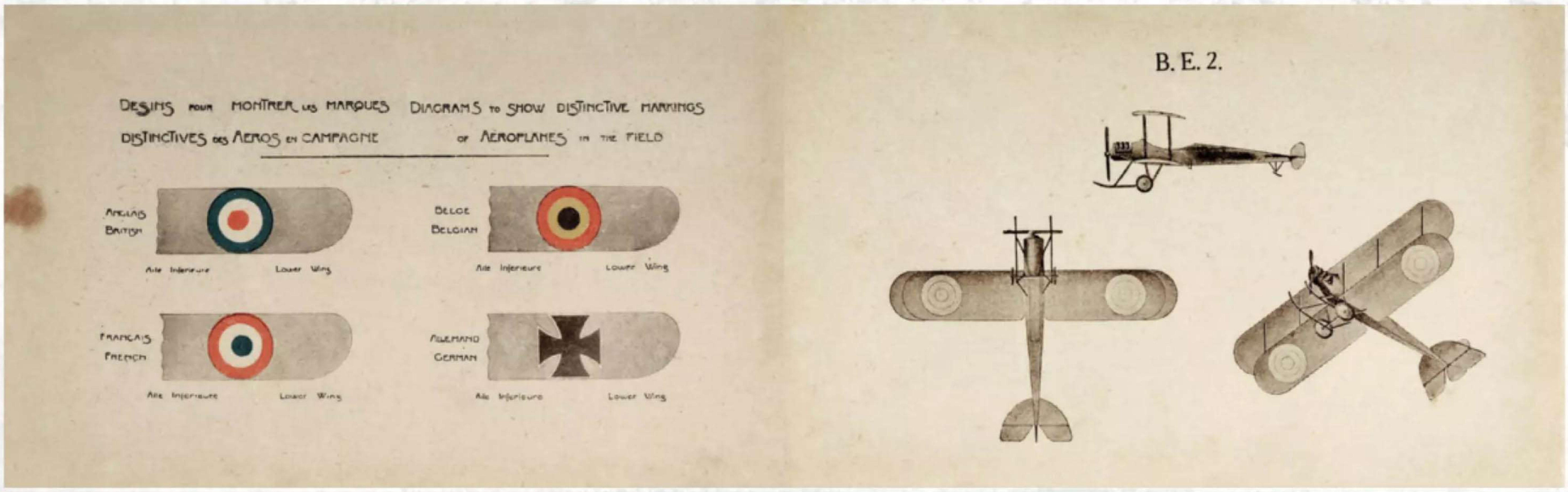
Citations 21 à l'O/de l'Armée: 21/7, 5/9, 12/12-15; 9/2, 26/3, 25/5, 25/6, 27/7, 24/8, 26/8, 3 & 23/9, 28/10, 20 & 26/12-16; 28/11/16

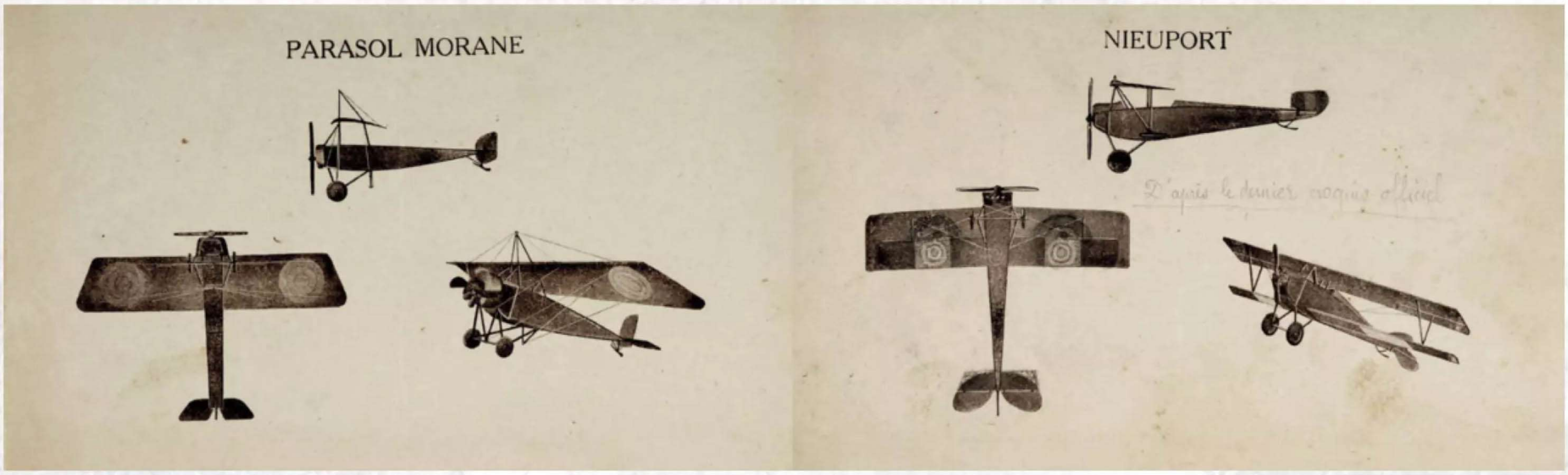
Actions d'éclat 12, 13 & 14/2, 26/3, 14/6, - 1917.

MOTIF
de la proposition
et avis du Chef de Corps
ou du Service

Pilote de combat incomparable.
Le 6 et 7 juillet a abattu ses 46e 47e et 48e avions ennemis.

Le 5 juillet, a livré un combat très dur, au cours duquel, il a été descendu — pour la septième fois, son avion criblé de balles.


DESINS POUR MONTRER LES MARQUES DISTINCTIVES DES AEROS EN CAMPAGNE
DIAGRAMS TO SHOW DISTINCTIVE MARKINGS OF AEROPLANES IN THE FIELD
ANGLAIS
BRITISH
Aile Inferieure
Lower Wing
BELGE
BELGIAN
Aile Inferieure
Lower Wing
FRANCAIS
FRENCH
Aile Inferieure
Lower Wing
ALLEMAND
GERMAN
Aile Inferieure
Lower Wing
B. E. 2.


PARASOL MORANE
NIEUPORT
D'après le dernier croquis allié

bigger groups. By May 1916, the German air service had lost the struggle for air supremacy over Verdun. The RFC also reorganized its squadrons and by June 1916 its fighter units, equipped with the de Havilland DH2, a pusher design, and Nieuport Scouts, gained the edge over the Germans during the Battle of the Somme. However, the Allied success was short-lived and the Germans hit back with new aircraft such as the Albatros DIII and grouped their squadrons into large mobile units, which could be deployed where needed to achieve local air superiority. The most famous of these was Jagdgeschwader 1 (JG1) led by Manfred von Richtofen. Its brightly coloured aircraft were known to the British as Richtofen's "Flying Circus". Such was the level of German success that during "Bloody April" 1917 the life expectancy of new RFC pilots was less than three weeks. New aircraft such as the Spad XIII, the SE5a and the Sopwith Camel swung the battle back in the Allies' favour in the summer of 1917. Despite the introduction of the excellent Fokker D VII in the following year, the German Air Service was overwhelmed by the mass of Allied aircraft deployed against it and by the end of the war in November 1918, could do little save mount local challenges to the Allies' dominance of the air.

Air combat gave rise to the phenomenon of the "ace", a status given to fliers who achieved a certain number of "kills" or victories (initially five, but the number increased as the war went on). These fliers became public heroes and were portrayed as "knights of the air", but air fighting was rarely chivalrous and was as deadly as that on the ground.

Georges Guynemer

(1894–1917)

Captain Georges Guynemer was not the highest-scoring French ace, but this modest, frail man captured the French people's hearts. So much so that when he failed to return from a patrol on 11 September 1917, many could not accept he had been killed and preferred to think he had simply flown off into the clouds.

All in all, Guynemer was credited with 53 victories. He flew some 660 hours and took part in more than 600 combats, mainly in Nieuports and Spads. Guynemer is still fondly remembered in France to this day and a monument to him stands in front of the headquarters of the Armée de l'Air in Paris.

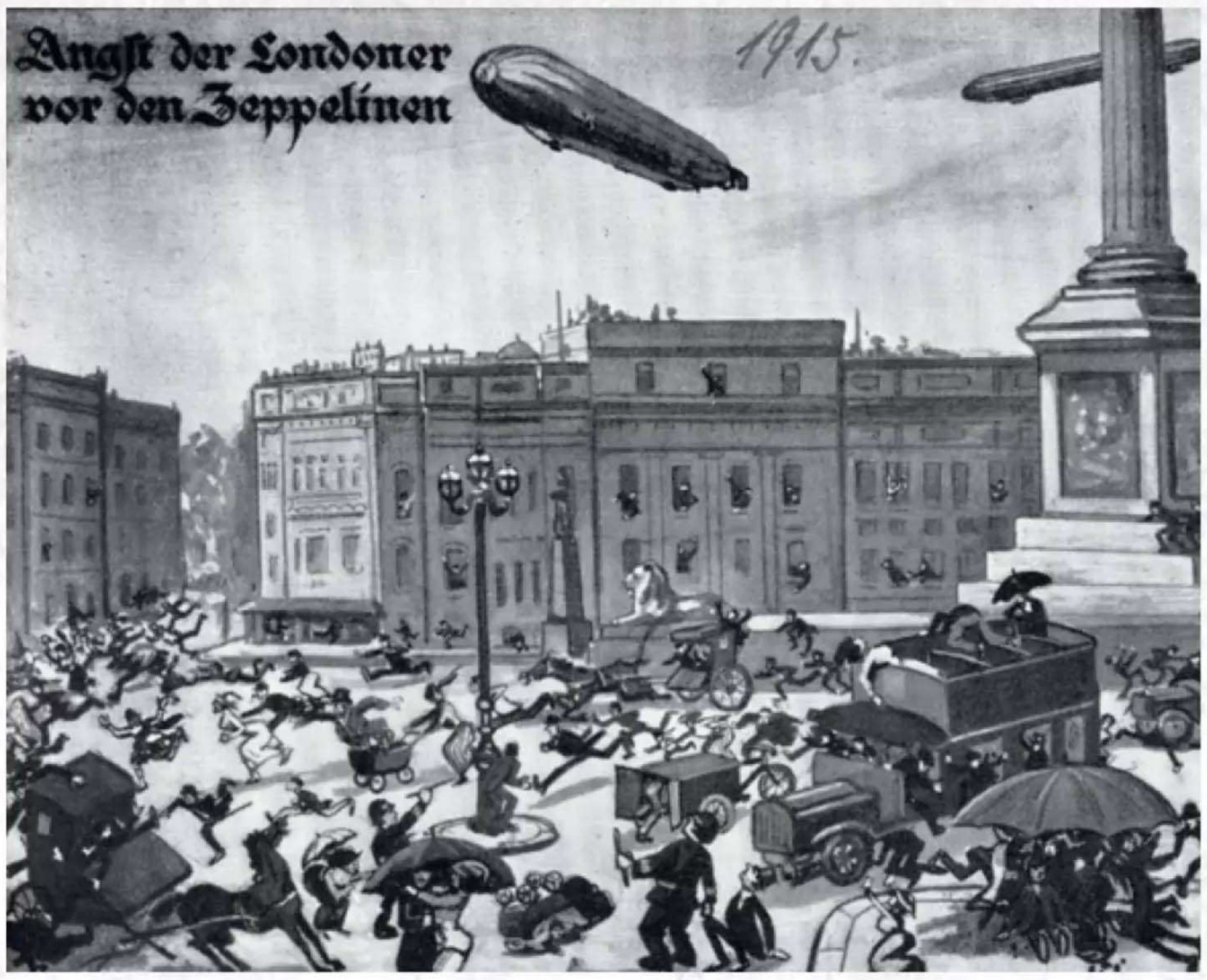
BOMBERS AND BOMBING

In 1914, the only aircraft capable of carrying a significant bomb load that also had the ability to reach strategic targets beyond the battlefield were the massive metal-framed Zeppelin and wooden-framed Schütte-Lanzes, airships of the Imperial German Navy and Army. In his 1908 novel The War in the Air, HG Wells described a fictional airship attack on New York. During the First World War, fiction turned to reality as German airships attacked French cities, including Paris, and in particular Britain, which was hit for the first time on 19 January 1915. Attacking at night, the German airships made a further 50 raids on Britain but their impact was limited as British defences improved. One of the most effective weapons used against them was explosive and incendiary ammunition fired from defending aircraft. The sight of a hydrogen-filled airship exploding was a horrendous spectacle not easily forgotten by any who witnessed it.

Of more consequence were raids on London and Paris by large German Gotha multi-engine bombers and the even larger R-planes. These started in May 1917 and in June of that year, London was hit by two dramatic daylight raids. Public outrage led to an immediate improvement in the city's defences. These became so effective that by September, the bombers had to attack by night. The raiders continued to get through, but as the air defence system, which included observer posts, anti-aircraft guns, searchlights, barrage balloons and fighters organized from control rooms, was improved, the Gothas suffered heavier losses. These, together with the German's need to use the bombers on the Western Front, led to the raids' ending in May 1918.

The raids did not affect the Allies ability to make war on Germany but they did force them to divert important resources to air defence that might otherwise have been used at the battlefront. Over 1,300 people were killed in Britain during the raids, a relatively small number compared with military casualties but one that made a deep impression on the British people, who demanded reprisal attacks on Germany.

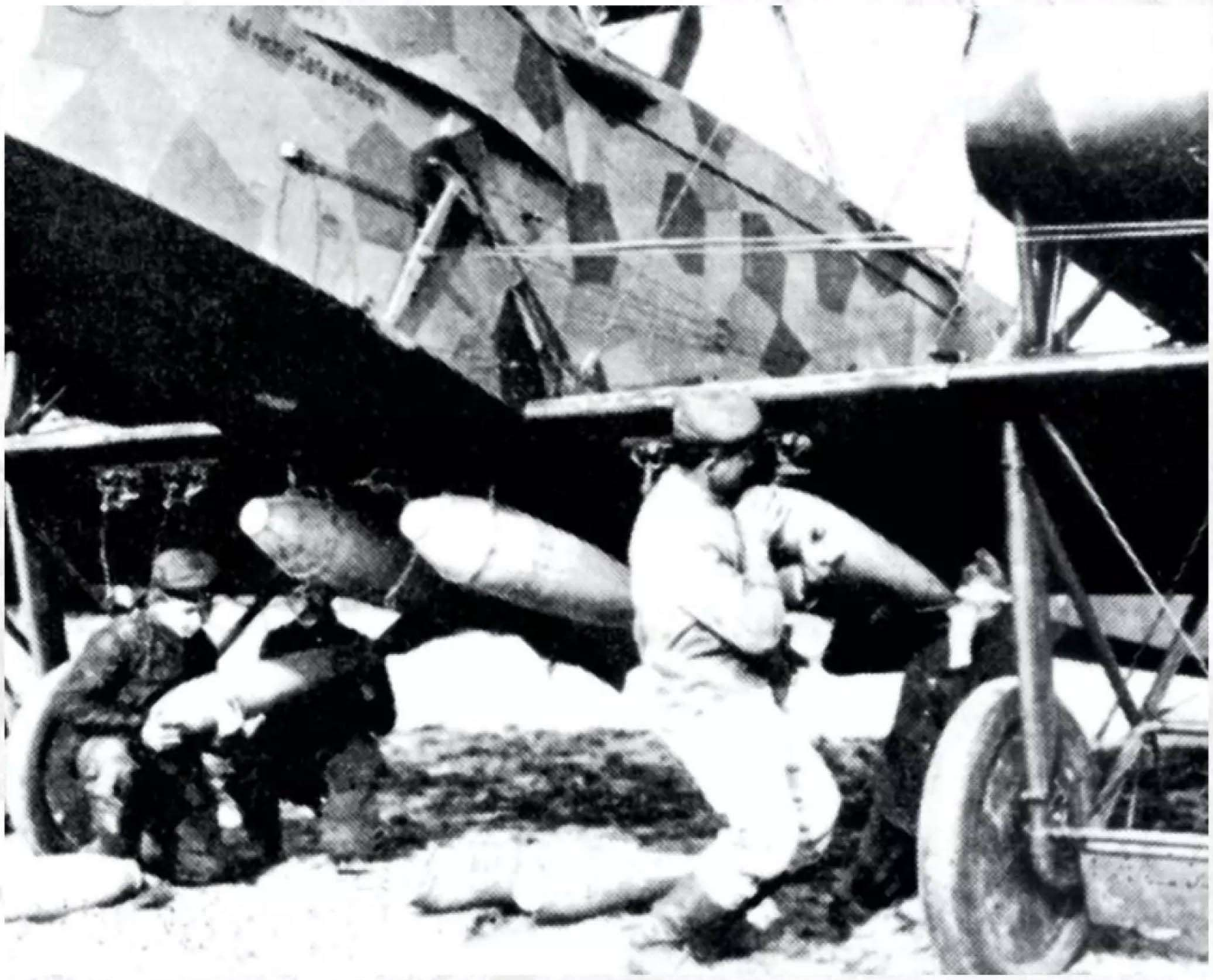
The French made bombing raids on Germany from 1915 but inflicted little damage. Attacks by the British Royal Naval Air Service (RNAS) in late 1916 and 1917 were also unsuccessful. Following the raids on London, there was a fresh impetus to renew attacks on Germany and to reorganize Britain's air services, and in April 1918 the Royal Air Force (RAF) was formed. In June


Angst der Londoner vor den Zeppelinen
1915.

ABOVE: After a German airship raid on London in 1915, soldiers and civilians gather in the streets between bomb-damaged buildings. London was bombed for the first time on 31 May that year.

LEFT: "Londoners fear the Zeppelin" – a 1914 German propaganda card. Although the German airship attacks killed 557 people throughout the war, their overall effect on the course of the conflict was rather limited and by 1916 British defence measures began to prevail.

OPPOSITE: A British Handley Page 0/400 coming in to land. The 0/400 was the RAF's main long-range strategic bomber during the First World War but the war came to an end before the Allied bombing campaign against Germany could have much effect.



LEFT: German armourers loading bombs on to a Gotha GIV. The "G" designation stood for Grossflugzeug or "large aeroplane". The twin-engine Gotha GIV became the mainstay of the German attacks on Britain after the Zeppelin threat receded.

OPPOSITE: Smoke pours out of the Central Telegraph Office in the aftermath of the second German daylight raid on London on 7 July 1917. The raid, carried out by 21 bombers, left 65 dead and 250 injured and sparked off anti-German riots in London's East End.

1918, the RAF also established the Independent Air Force (IAF) in France under Major-General Trenchard. Its mission was to bomb Germany, but the majority of its operations were tactical in support of the Allied armies, which now included the Americans (who had entered the war in 1917). The conflict ended before the IAF could conduct a sustained strategic bombing campaign and its raids on Germany had little effect overall. However, if the war had continued, the campaign would have been stepped up with new aircraft such as the British Vickers Vimy and the French Farman Goliath.

Italy joined the Allies in 1915, and used its large Caproni bombers to attack Austria. Italian Giulio Douhet called for Italy to create a large bomber force but Italian raids, like those of its allies, were also limited in effect. Nevertheless, air power advocates such as Douhet, the American General Billy Mitchell, and Trenchard, had a profound effect on inter-war thinking about the significant threat and war-winning potential of the strategic bomber.

Handley Page 0/400

At the start of the war, the British Admiralty had responsibility for the defence of the United Kingdom against air attack. It had some success raiding German airship bases, but decided it needed larger aircraft. This led to the development of the Handley Page 0/100 which flew in 1915 and the improved 0/400 of 1918. This large (it had a 30-metre [100-foot] wing span) twin-engine bomber equipped squadrons of the RAF's Independent Air Force which carried out night raids on Germany. The four-engine Handley Page V/1500 went in to production in 1918 but was too late for its planned use of raiding Germany from bases in eastern England.

Peter Strasser

(1876–1918)

Peter Strasser was commander of the Imperial German Navy's airship fleet during the First World War. Under Strasser, airships attacked London, Paris, Antwerp and other ports and cities. Strasser strove to make the airship an effective weapon and believed that Britain could be beaten by the destruction of its cities, factories and dockyards. He regularly flew on missions, but was killed before he could achieve his ambition of a decisive raid across the Atlantic on New York. Strasser's Zeppelin L70 was shot down off the east coast of England on 5 August 1918. There were no survivors.

Nº1
CHEAPSIDE

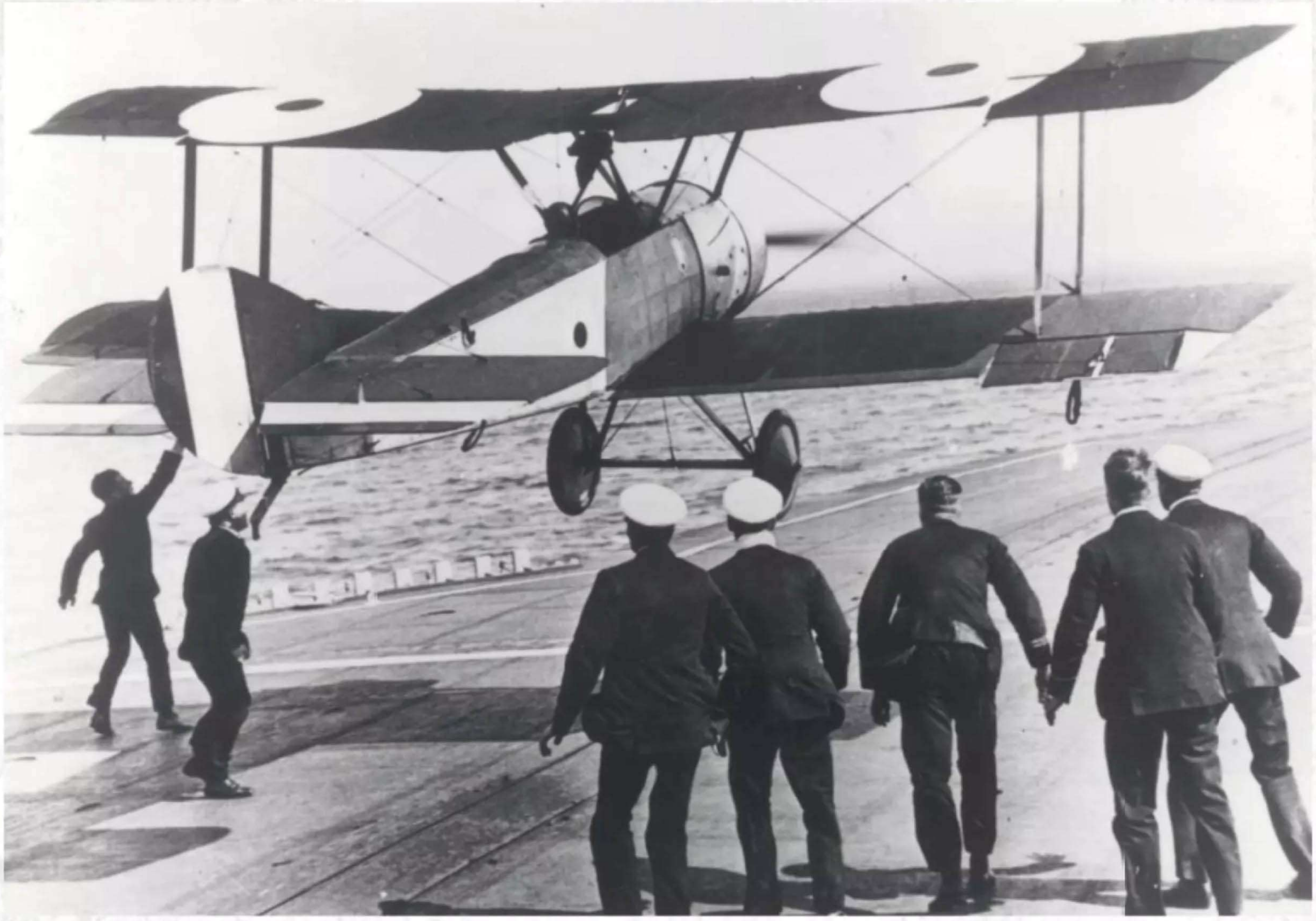
INDUSTRY AIRCRAFT AND AIR FORCES

During the First World War the aeroplane developed into an effective and reliable machine used by the military for reconnaissance, artillery-spotting, air-fighting, ground-strafing, tactical and strategic bombing; roles that would continue throughout subsequent conflicts. Aircraft and airships were also used at sea by naval air services. Airships, particularly non-rigid airships, or blimps as they became known, together with flying boats, were used for long-range reconnaissance and increasingly important anti-submarine work.

The Royal Naval Air Service was quick to see the potential of deploying aeroplanes on ships. It first used seaplanes on carriers converted from cross-Channel ferries and then modified HMS Furious with a forward aircraft deck in August 1917. Taking off was comparatively easy, but landing was a much more difficult proposition. Squadron Commander E H Dunning managed this twice in a Sopwith Pup in August 1917 but was tragically drowned on the third attempt. In 1918 HMS Argus, the first true aircraft carrier, proved significantly more successful. If the war had continued, the Navy would have used it to launch an attack on its German counterpart.

The aircraft available to the military in 1914 were produced mainly by small companies, but these grew into large industrial concerns supported by government backing and contracts. Companies from outside aviation, particularly motor-car manufactures, also became involved in the burgeoning aircraft industry, along with a host of engineering sub-contractors. The war became a battle for production as well as a battle for control of the skies. It was a war that the Allies won convincingly. For example, Britain made 55,092 airframes during the conflict, whilst France made 51,700 and Germany just 38,000.

The Allies took a conservative approach to aircraft design and construction materials. Their aeroplanes were largely wooden-framed, fabric-covered biplanes strengthened with struts and wires. More powerful and reliable engines gave improved performance. Firepower was increased with the addition of more machine-guns or by building bigger machines capable of carrying greater bomb loads. The Germans were more creative in



LEFT: With the help of crew members on the deck of HMS Furious on 2 August 1917, Squadron Commander E H Dunning in a Sopwith Pup, makes the first landing on a moving ship. Dunning died five days later while trying to repeat his success.

RIGHT Aircraft manufacturer Anthony Fokker (centre) poses with German flying aces Bruno Loerzer (left) and Herman Göring (right) in 1918. Unable to make aircraft in Germany after the war, Fokker moved to the US and established a successful company there. Göring led the German air force during the Second World War and Loerzer served under him, commanding units during the Battle of Britain in 1940.

BELOW No. 1 Squadron RAF with their SE5a aircraft at Claremarais, France in 1918. At the end of the war in November 1918, the RAF was the world's largest air force, operating over 26,000 aircraft from 675 airfields.

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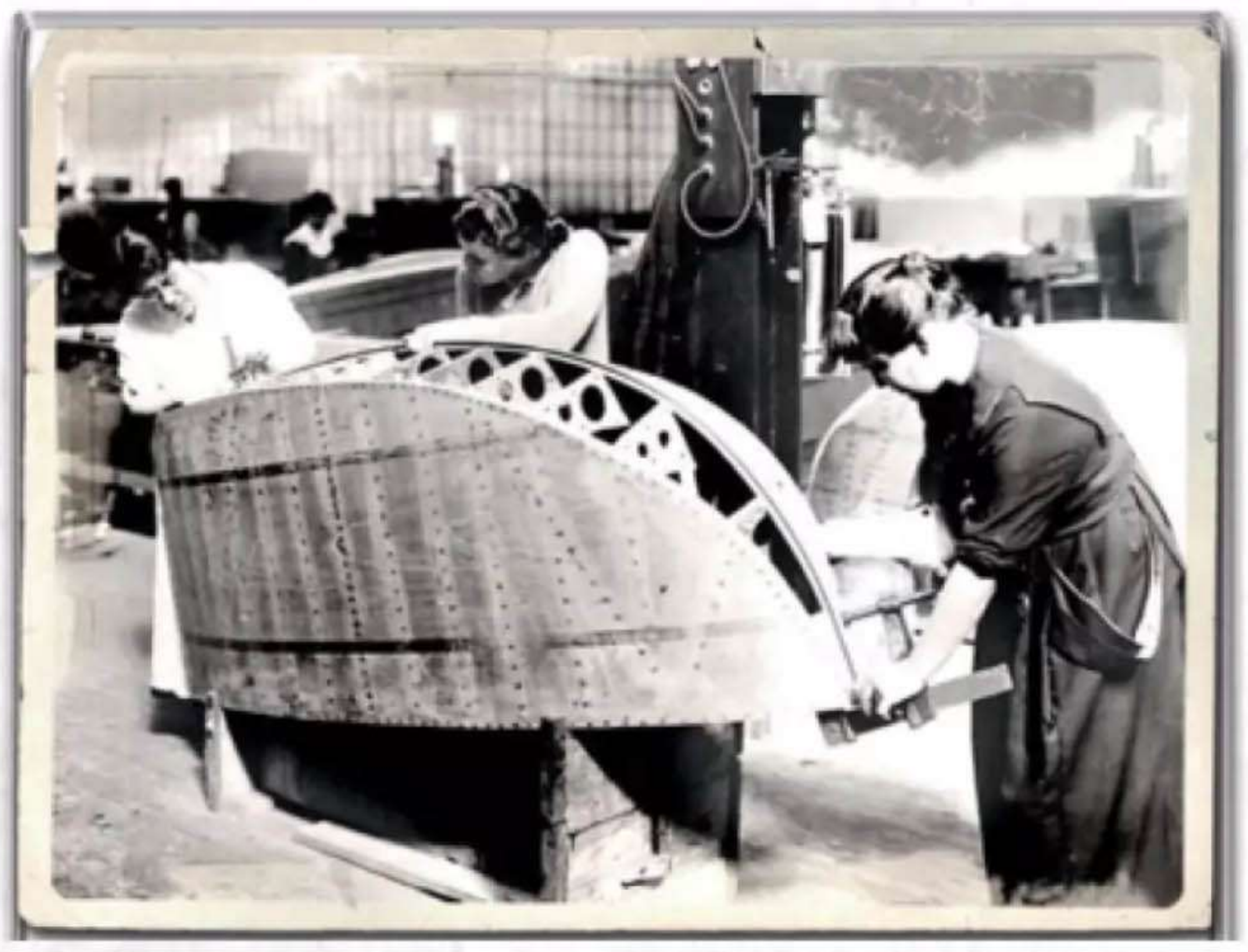
LEFT: The 1000th DH4 to be made at the Dayton-Wright Airplane Company in the US, photographed in July 1918. Entering the war in 1917 the US opted to build European combat designs under licence to save time and deliver aircraft to the front quickly.

their use of materials. Welded steel tubing was used for frames and on some aircraft plywood was shaped to create the outer surface. They were also the first to introduce an all-metal aircraft, the Junkers J4, an armoured infantry support monoplane made of duralumin which went into combat from 1917. The Junkers J8 with its cantilevered wing (a wing with no external bracing) was even more innovative and indicated the direction aircraft design was to take.

By 1918, the era of the lone ace hunting his prey had passed. Air fighting had come to rely on teamwork and larger formations. Up to 60 aircraft at a time might be seen manoeuvring for position before attacking and breaking up into the whirling mass of a "dog-fight". Air forces also grew into complex organizations that deployed large numbers of men, women and machines. In 1918, with nearly 300,000 personnel the RAF was the largest. It was also the first air force to be organized separately and independently from an army or navy.

The creation of the long-range bomber was to give the air forces their main independent strategic mission. It was the arrival of these large aircraft that also led to the development of commercial aviation as well as the destruction of European and Japanese cities from the air in the Second World War.



ABOVE: Female factory workers construct the wing-tip of a naval aircraft, c.1918.

Aircraft Factories

Pre-war manufacturers re-used existing large open structures to make aircraft. During the war, these facilities were expanded and many new factories built. Aircraft were constructed in batches with the fuselages on trestles and then on their wheels so they could be moved efficiently through the factories. Wings and other sub-assemblies were added, then the aircraft were covered in fabric and the engine and other components installed. For the first time, thousands of women worked in the factories undertaking tasks previously carried out by men. However, many lost their jobs when the aircraft industry contracted after the war and the men returned to work.

Hugh Trenchard

(1873–1956)

Hugh Trenchard joined the British Army in 1893. He fought in the Boer War and later saw service in Nigeria. Trenchard learnt to fly in 1912. He was commander of the Royal Flying Corps on the Western Front from 1915 to 1917 and was briefly the RAF's first Chief of the Air Staff before commanding the Independent Air Force of bombers in France in 1918. Trenchard became Chief of the Air Staff again in 1919. He spent most of the 1920s establishing the RAF's status and future and was an advocate for the independent use of air power.

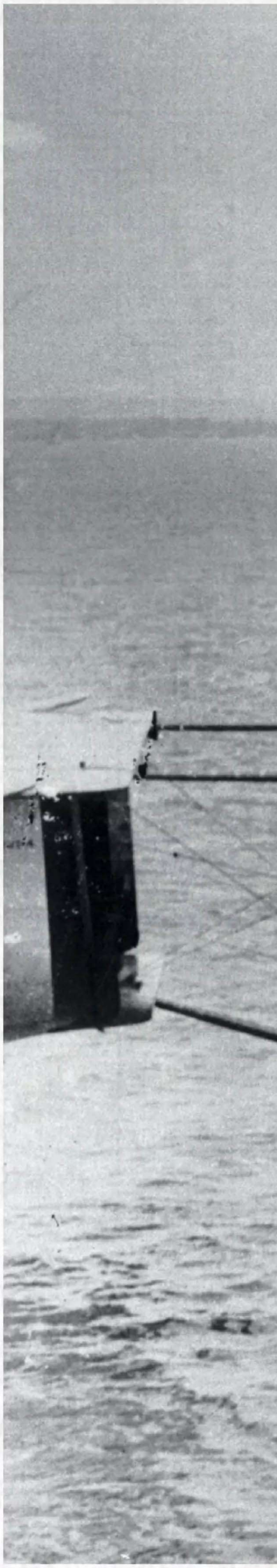
THE FIRST TRANSATLANTIC FLIGHTS

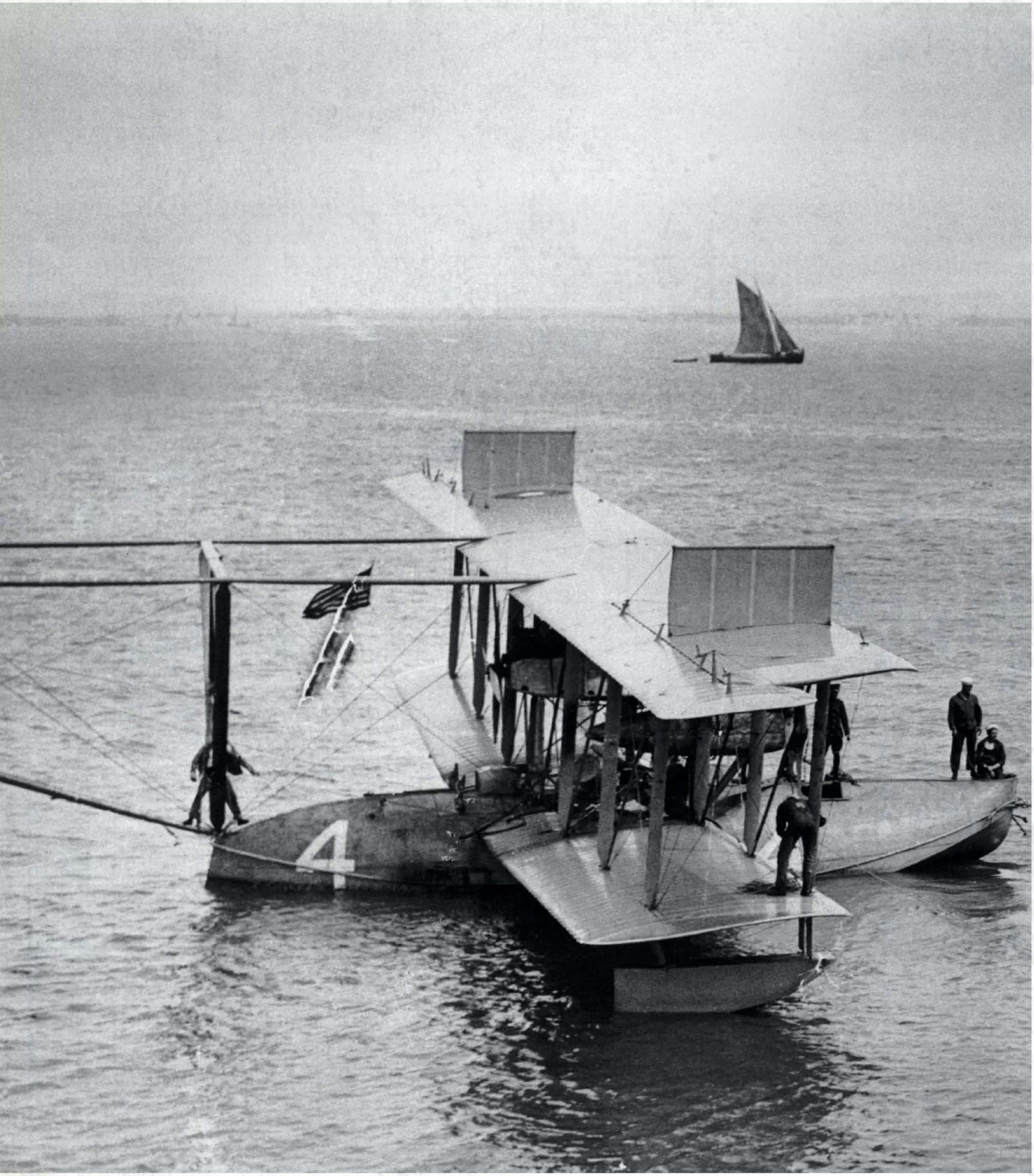
In 1913, Lord Northcliffe, the owner of the Daily Mail offered a $10,000 prize for the first direct flight across the Atlantic. Glenn Curtiss built the flying boat America in order to make an attempt at the prize, but the outbreak of war put an end to preparations. During the war, the US Navy asked Curtiss to construct the NC flying boats, which in 1919 it decided to use to fly across the Atlantic in stages. Three flying boats set off on 8 May 1919 but only one, NC-4 under the command of Lieutenant Commander Albert C Read, completed the entire journey. Starting at Long Island and after stops at Chatham, Halifax (Novia Scotia), Tresspassy Bay (Newfoundland) and the Azores, the NC-4 landed at Lisbon in Portugal on 27 May after a 6,400-kilometre (4,000-mile) flight.

With Northcliffe's prize still unclaimed, five teams from British aircraft manufacturers set out to win it in 1919. A team from Shorts tried to fly east–west across the Atlantic but ditched into the sea on 18 April. The other teams from Martinsyde, Handley Page, Sopwiths and Vickers planned on starting from Newfoundland and flying west. The Sopwith Atlantic flown by Harry Hawker and Kenneth Mackenzie-Grieve took off on 18 May, but following engine problems, went down in the ocean well over half-way across. It was assumed the two men were dead, but miraculously the pair were picked up by a ship. The vessel did not have a radio so it was not until 25 May that the world heard Hawker and Mackenzie-Grieve had survived. They received a £5,000 cheque from Lord Northcliffe for their "magnificent failure". Two hours after Hawker and Mackenzie-Grieve departed, Freddie Raynham and "Fax" Morgan's Martinsyde aircraft Raymor crashed

LEFT: British aviators Captain John Alcock (right) and Lieutenant Arthur Whitten-Brown pose at Clifden, Ireland after the first non-stop transatlantic flight by aeroplane in June 1919.

RIGHT: US Navy Curtiss NC-4 which made the first crossing of the Atlantic in stages in May 1919. The NC-4's crew of six was commanded by Lieutenant Albert C Read.

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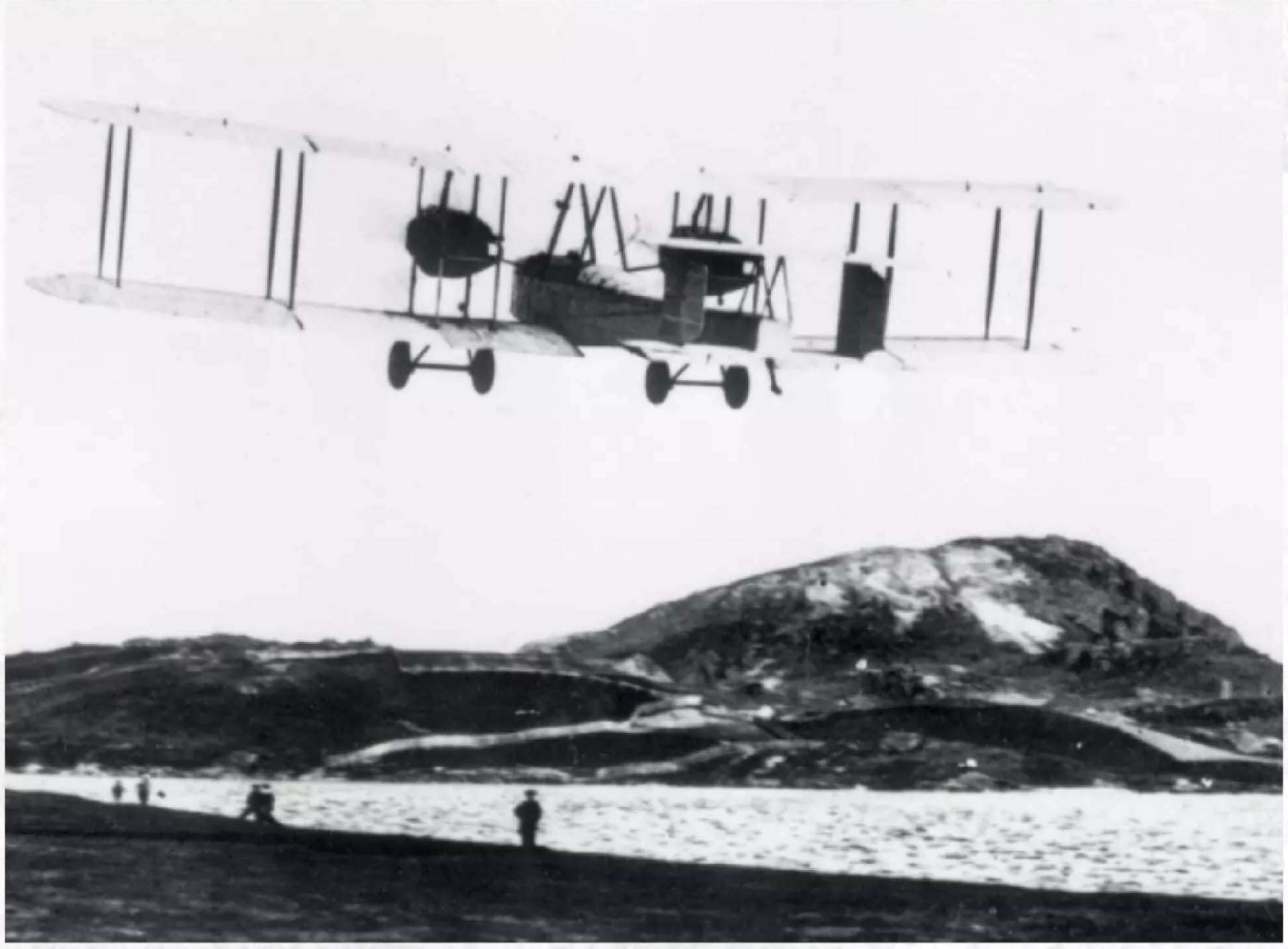
R 34



on take-off, injuring Morgan and bringing their attempt at the prize to an end.

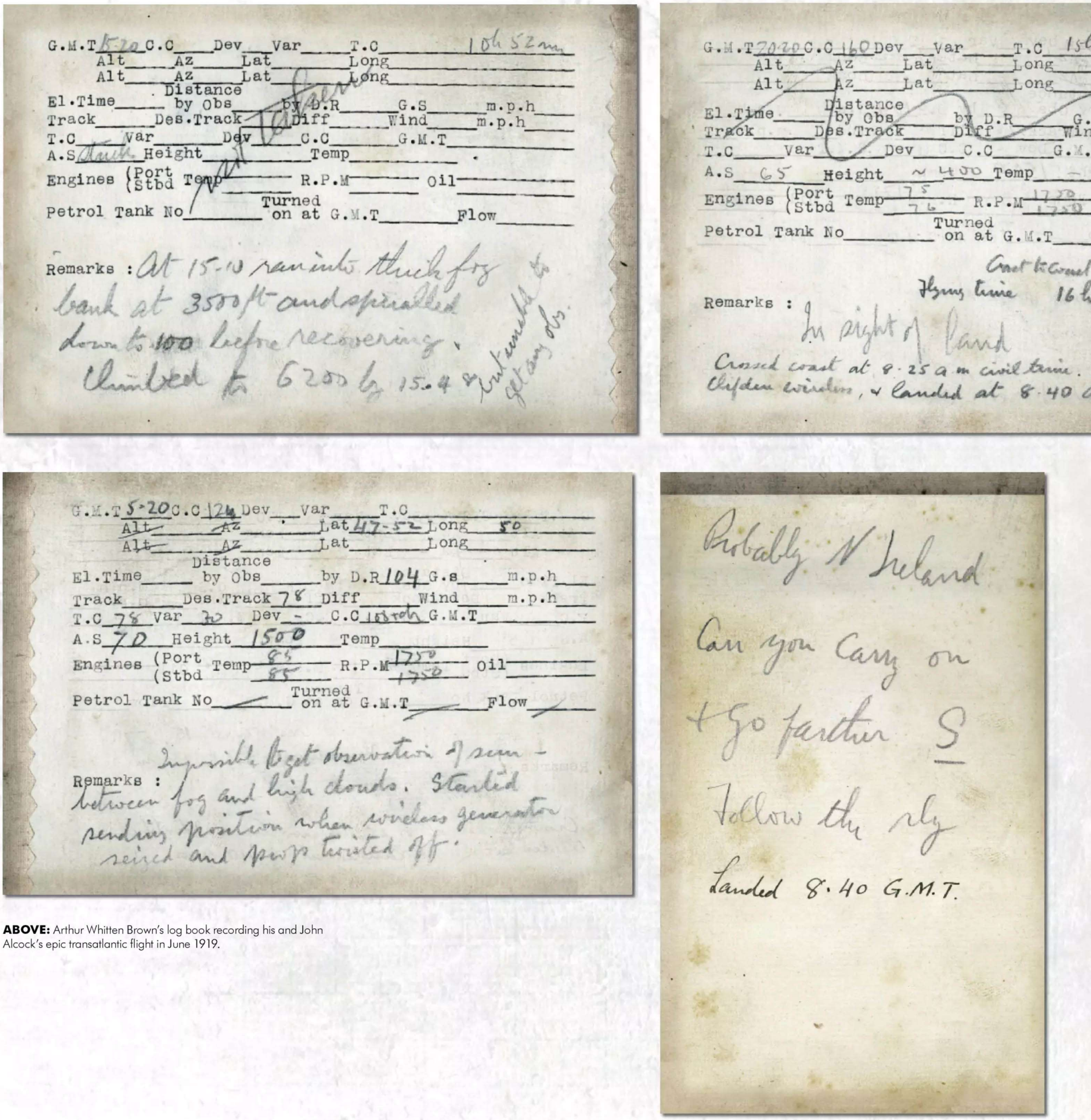
By 14 June, the Vickers team of pilot John Alcock and navigator Arthur Whitten Brown were ready to go in their modified Vickers Vimy. After a difficult take off in their over-loaded aircraft, they suffered a series of problems. The generator for the radio failed and their electrically heated suits did not work, making flying their open cockpit aircraft very difficult when they ran into bad weather. Flying at night and disorientated by a storm, they nearly span into the sea when an engine stalled but Alcock managed to regain control. Flying on and into snow and hail, Brown even had to climb out onto the wing to de-ice an engine at one point.

LEFT: Alcock and Brown's modified Vickers Vimy takes off on 14 June 1919 at the start of their 16-hour flight to Clifden, County Galway, Ireland.

ABOVE: British airship R 34 at Roosevelt Flying Field, Mineola, New York on 6 July 1919 after making the first east-west aerial crossing of the Atlantic. The airship carried a crew of 30 plus one stowaway and the ship's cat. Six hundred men were needed on the ground to assist with her arrival.

Harry Hawker
(1889–1921)

Australian Harry Hawker joined T O M Sopwith's fledgling aviation company at Brooklands in 1912 as a mechanic. Hawker quickly learnt to fly, set new records and worked on the Sopwith Tabloid. He continued with Sopwith as chief test pilot during the First World War and was involved in the design of many of the company's famous wartime aircraft including the Sopwith Pup and Camel. Sopwith Aviation went into liquidation in 1920. Hawker and Sopwith, with others, formed a new company which became known as Hawker Aircraft. Tragically, Hawker died in an air crash in 1921.



G.M.T 15·20 C.C ___ Dev ___ Var ___ T.C 10h 52m
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Alt ___ Az ___ Lat ___ Long ___
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A.S Stuck Height ___ Temp ___
Engines {Port {Stbd Temp ___ R.P.M ___ Oil ___
Petrol Tank No ___ Turned on at G.M.T ___ Flow ___

Remarks : At 15-10 ran into thick fog bank at 3500 ft and spiralled down to 100 before recovering. Climbed to 6200 by 15.4 & but unable to get any obs.

G.M.T 20·20 C.C 160 Dev ___ Var ___ T.C 15·
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Alt ___ Az ___ Lat ___ Long
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Track ___ Des.Track ___ Diff ___ Win
T.C ___ Var ___ Dev ___ C.C ___ G.M.
A.S 65 Height ~ 400 Temp –
Engines {Port {Stbd Temp 75 / 76 R.P.M 1750 / 1750
Petrol Tank No ___ Turned on at G.M.T ___

Coast to Coast
Flying time 16 h

Remarks : In sight of land

Crossed coast at 8·25 a.m civil time. Clifden wireless, & landed at 8·40

G.M.T 5·20 C.C 124 Dev ___ Var ___ T.C ___
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~~Alt~~ ___ ~~Az~~ ___ Lat ___ Long ___
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T.C 78 Var 30 Dev – C.C [illegible] G.M.T ___
A.S 70 Height 1500 Temp ___
Engines (Port (Stbd Temp 85 / 85 R.P.M 1750 / 1750 Oil ___
Petrol Tank No — Turned on at G.M.T — Flow —

Remarks : Impossible to get observation of sun – between fog and high clouds. Started sending position when wireless generator seized and props twisted off.

Probably N Ireland

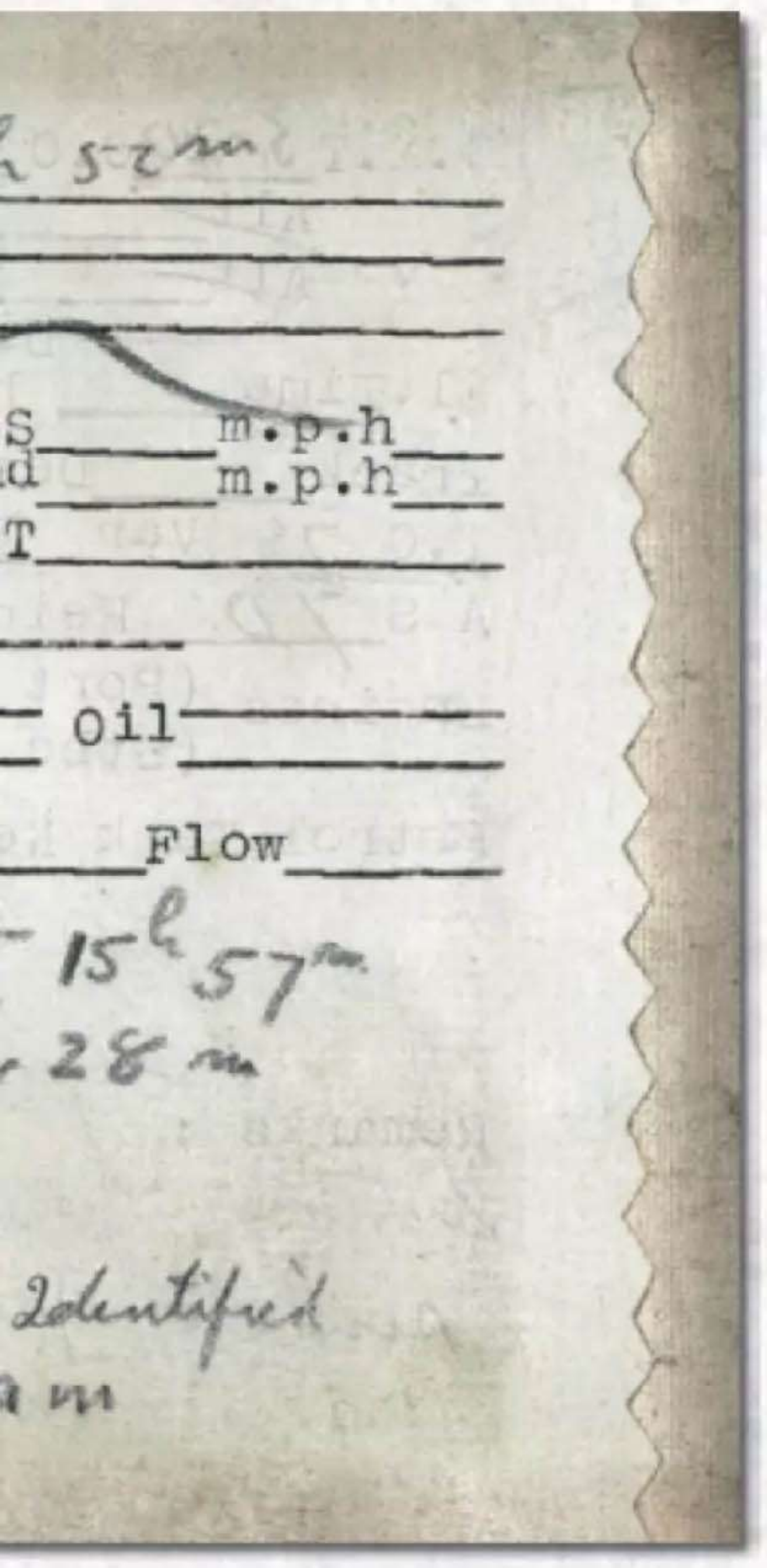
Can you carry on

+ Go farther S

Follow the rly

Landed 8·40 G.M.T.

ABOVE: Arthur Whitten Brown's log book recording his and John Alcock's epic transatlantic flight in June 1919.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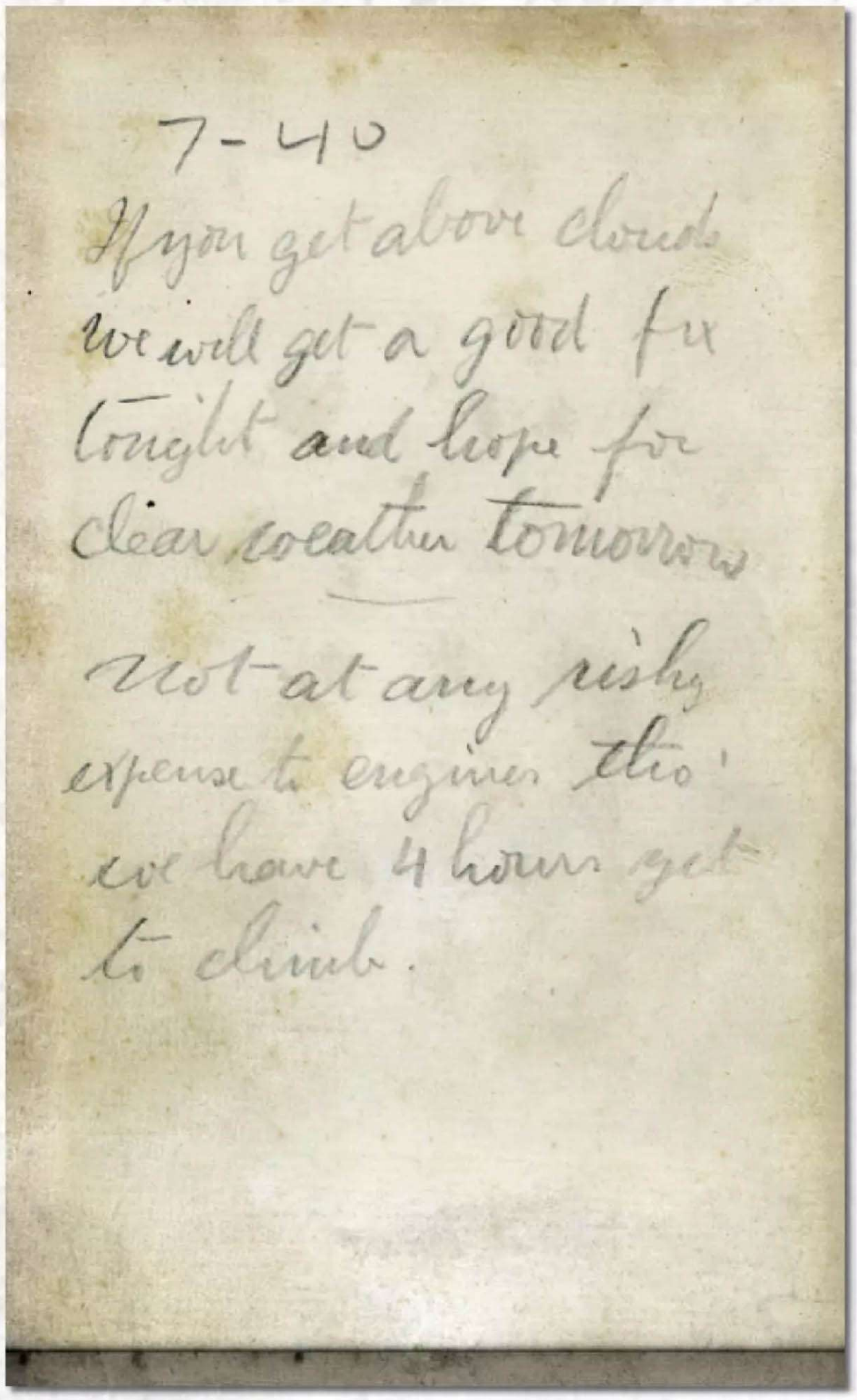
7-40
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tonight and hope for
clear weather tomorrow

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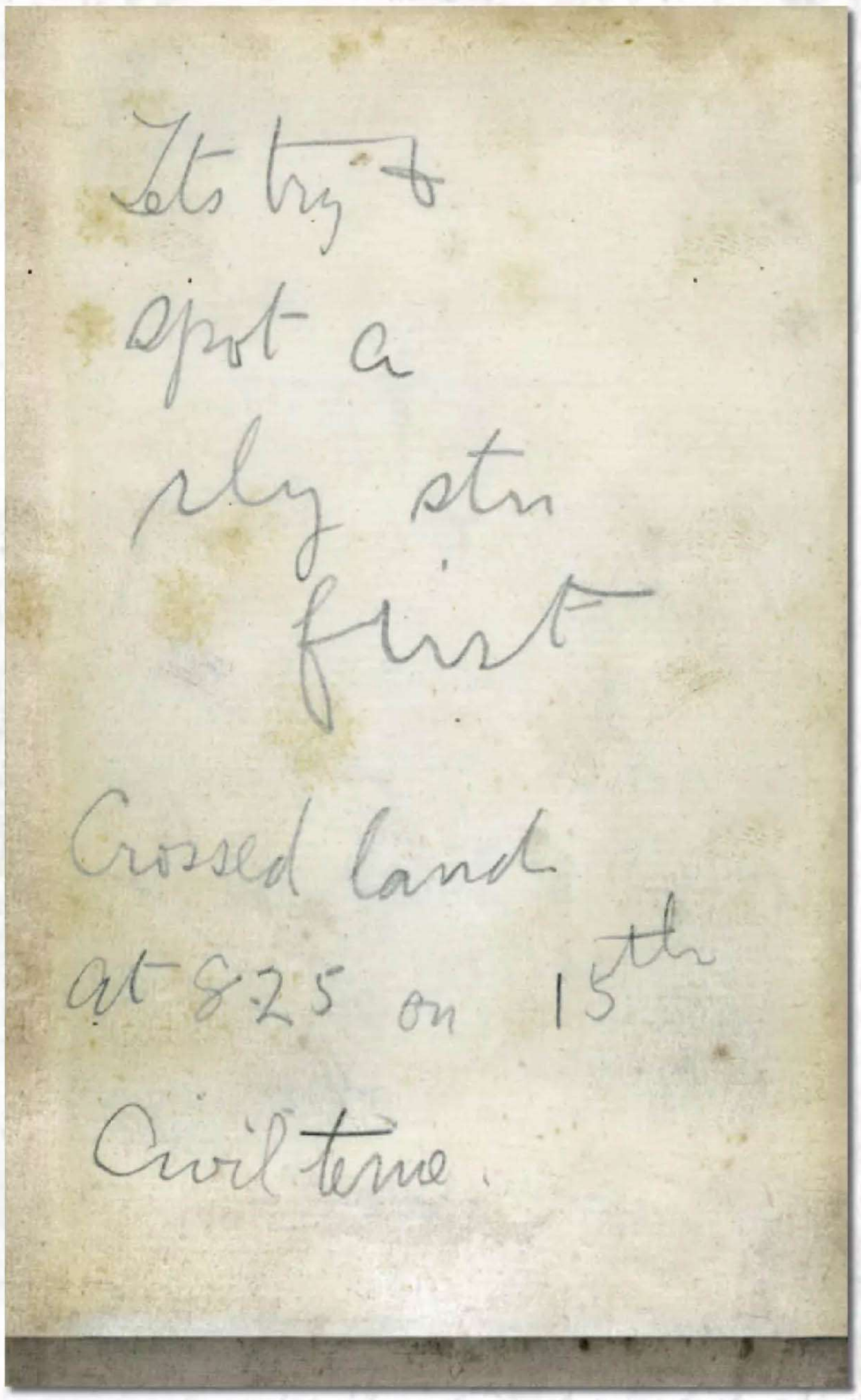
we have 4 hours yet
to climb.


Lets try to
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Crossed land
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Civil time.

Frozen and exhausted, and after more than 16 hours in the air, the two aviators were relieved to spot the coast of Ireland where they landed in marshy ground near Clifden. The Vimy tipped up on its nose at the end of its 3,115-kilometre- (1,936-mile-) flight, but both men emerged safely from the crash. Back in Newfoundland and with the Atlantic now conquered, the Handley Page team decided not to fly. Alcock and Brown received a hero's welcome in London as well as the prize for their flight which appeared to some to herald the imminent start of transatlantic air travel. However, it was to be 20 years before aircraft technology had moved on sufficiently for regular and reliable transatlantic passenger aeroplane flights to become established.

Zeppelins had already flown passenger flights in pre-war Germany, so airships seemed to offer the greatest potential for long-distance passenger travel by air. This was confirmed by the flight of British military airship R 34, which made the first double crossing of the Atlantic by air in July 1919. R 34 was virtually a copy of a captured Zeppelin which had been forced to land in Britain during the war. The airship, under the command of Major G H Scott and with a crew of 30, set off from East Fortune, Scotland on 2 July 1919. R 34 reached New York on 6 July having spent 108 hours in the air and returned to Britain by 13 July after a total flight of 10,185 kilometres (6,330 miles). Passenger-carrying transatlantic Zeppelin flights commenced in 1928.

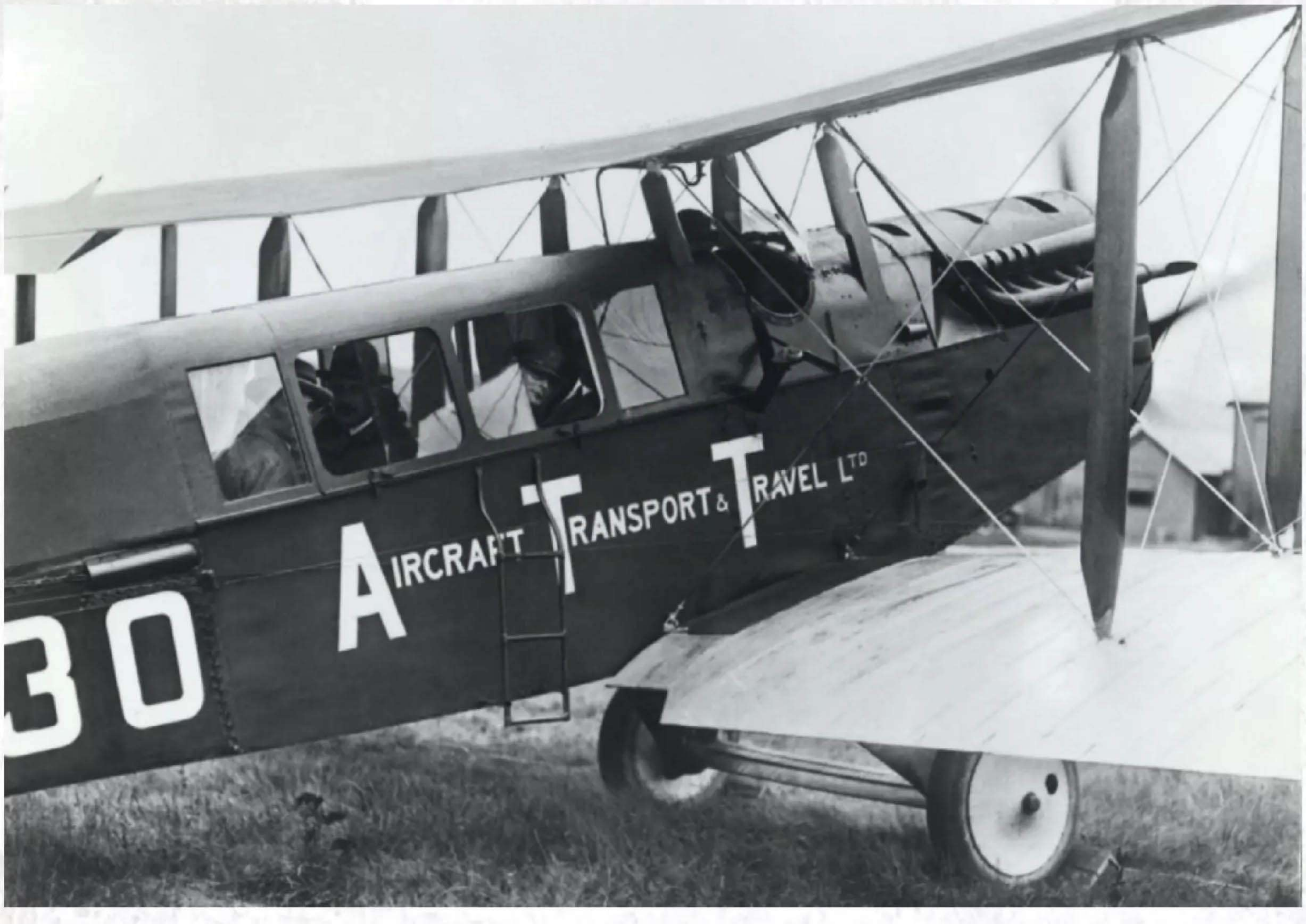
John Alcock and Arthur Whitten Brown

John Alcock (1892–1919) and Arthur Whitten Brown (1886–1948) both served in the Royal Flying Corps during the First World War. Coincidently both were shot down and spent time as prisoners of war but did not meet until Brown sought work at Vickers, where Alcock was a test pilot. They teamed up to make the first non-stop transatlantic aeroplane flight in 1919. Both were knighted in the same year and their Vickers Vimy was presented to the nation for display at the Science Museum in London on 15 December 1919. Alcock was killed three days later in a flying accident. Brown never flew again.

AVIATION IN THE 1920s AND 1930s

In the years after the First World War, demand for aircraft was greatly reduced and, initially, manufacturers found continuing in business difficult. To survive, many were forced to produce alternative products, because air forces, struggling to find new roles in a more peaceful world, were severely cut back. Although engine power was steadily increased and more metal came to be used in aircraft construction, the machines that the military flew in the mid-1930s looked much the same as their First World War counterparts. Instead, it was to be civil aviation that saw the biggest developments. Initially, passenger aircraft were based on military designs; the first international daily scheduled passenger service in the world was established by Aircraft Transport and Travel in August 1919 with the flight by a de Havilland DH 16, a civilian version of the DH 9A bomber, between Hounslow, London and Le Bourget, Paris.

However, aircraft designed specifically for civil aviation soon replaced wartime types. These grew in numbers and sophistication and by the 1930s, large luxurious biplanes, sleek new monoplanes and colossal airships and flying boats were regularly criss-crossing the world along a network of air routes run by efficient airlines. Designers worked to build better performing aircraft which set new records for distance, speed and altitude. Air races attracted large crowds and record-breaking flights – and the pilots who made them – continued to capture the public's imagination. The Schneider Trophy race, a competition for seaplanes, was won by France in 1913 with an average speed of 74 kilometres per hour (46 miles per hour). A Supermarine S6B, designed by R J Mitchell, won the trophy for Britain in 1931 with a speed of 548.1 kilometres per hour (340.6 miles per hour), and went on to set a new world record of 655.8 kilometres per hour (407.5 miles per hour) showing how far aviation had progressed. Similarly, in 1924 two US Army Air Service Douglas World Cruisers were the first aircraft to travel completely round the world in an incredible 42,400-kilometre (26,345-mile) journey that



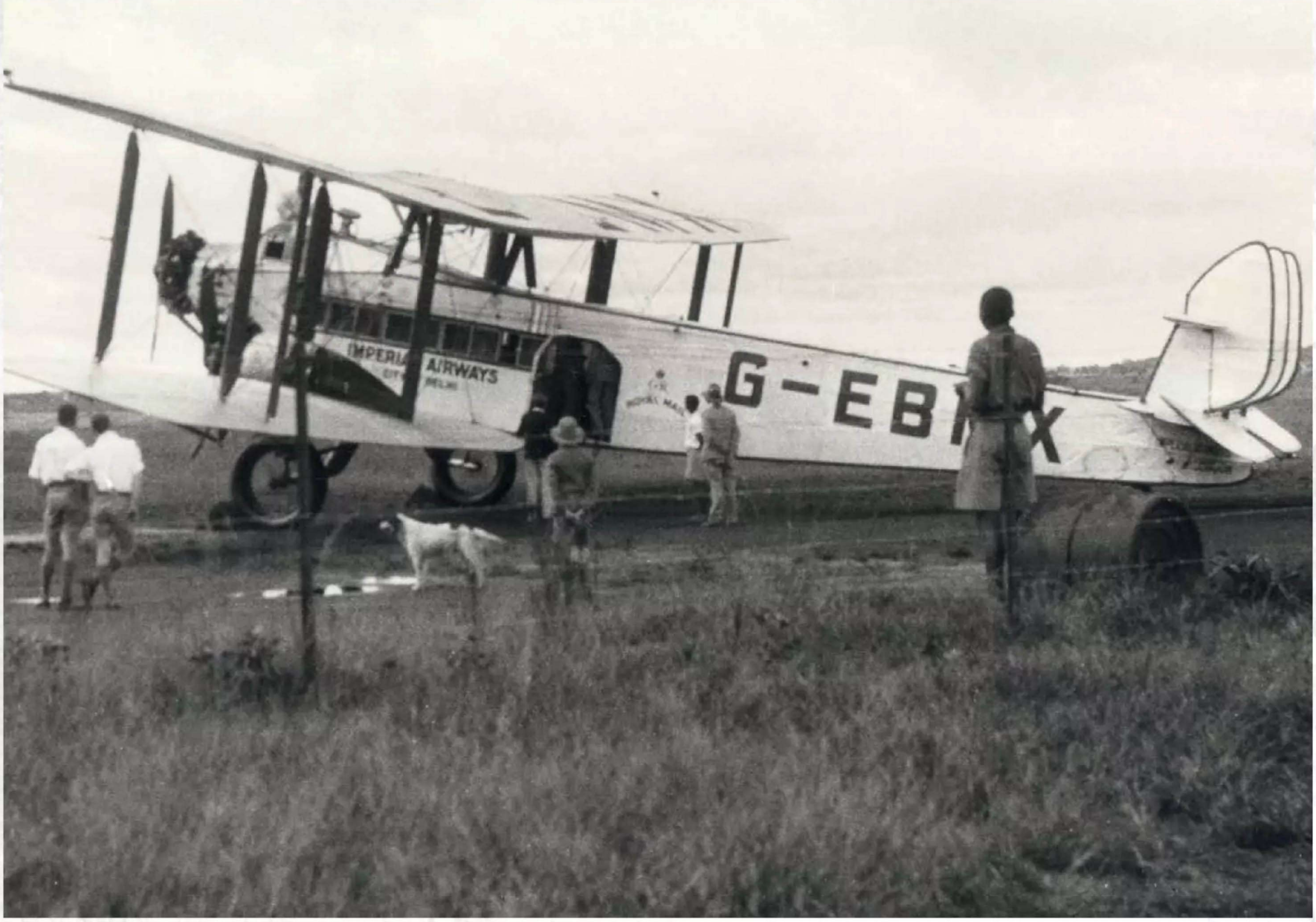
LEFT: An Aircraft Transport and Travel de Havilland DH 16 in 1919. Its four passengers each paid £21 for the flight from Hounslow, London to Le Bourget, Paris.

Alan Cobham
(1894–1973)

Alan Cobham learnt to fly in the RFC during the First World War. After a time with a company providing pleasure flights, he joined de Havilland Aeroplane Hire Service in 1921. His flights to Europe and North Africa in 1922, to Cape Town in 1924 and to Australia in 1926, helped to establish routes used by Imperial Airways. To encourage "air-mindedness" and aviation in the United Kingdom, in 1932 Cobham launched the National Aviation Day Campaign with a touring air display. A pioneer of in-flight refuelling, he set up Flight Refuelling Ltd in 1932.

LEFT: Handing over a parcel to the US air mail service in 1925. Initially carrying mail was as commercially important to the airlines as transporting passengers.

BELOW: The De Havilland DH 66 Hercules and the Armstrong Whitworth Argosy were Britain's Imperial Airways' main aircraft during the 1920s. Journeys along Imperial's empire routes could take several days and include overnight stops and various different modes of transport.



ABOVE: Passengers waiting to board a Ford-Trimotor in the US. Made by Henry Ford from 1926, the Trimotor seated 13 passengers. Its three engines made it reliable but noisy, and because of its all-metal body it became commonly known as the "Tin Goose".

took six months. Only seven years later in 1931, American Wiley Post and navigator Harold Gatty managed to circle the globe in eight days and 16 hours in his Lockheed Vega Winnie Mae.

Other fliers such as Englishman Alan Cobham and Frenchman Jean Mermoz made their names by making route-proving flights for mail and passenger carrying services. Trail-blazing flights could be very dangerous. In 1926, Cobham flew his DH 50 float plane to Australia and back but his mechanic Arthur Elliot was killed by a bullet fired from the ground whilst flying over Iraq. When Jean Mermoz went down in the desert in North Africa in 1926 he was held prisoner by tribesmen until a ransom was paid for his release. After many epic flights in South America in the late 1920s, Mermoz and the crew of his flying boat La Croix du Sud were lost over the South Atlantic in 1936.

For those who could afford them, passenger flights were not quite as hazardous, but in the 1920s with no heating, wicker seats, basic toilet facilities and travelling at heights that were badly affected by adverse weather conditions, flights were often cold and uncomfortable. With no insulation to

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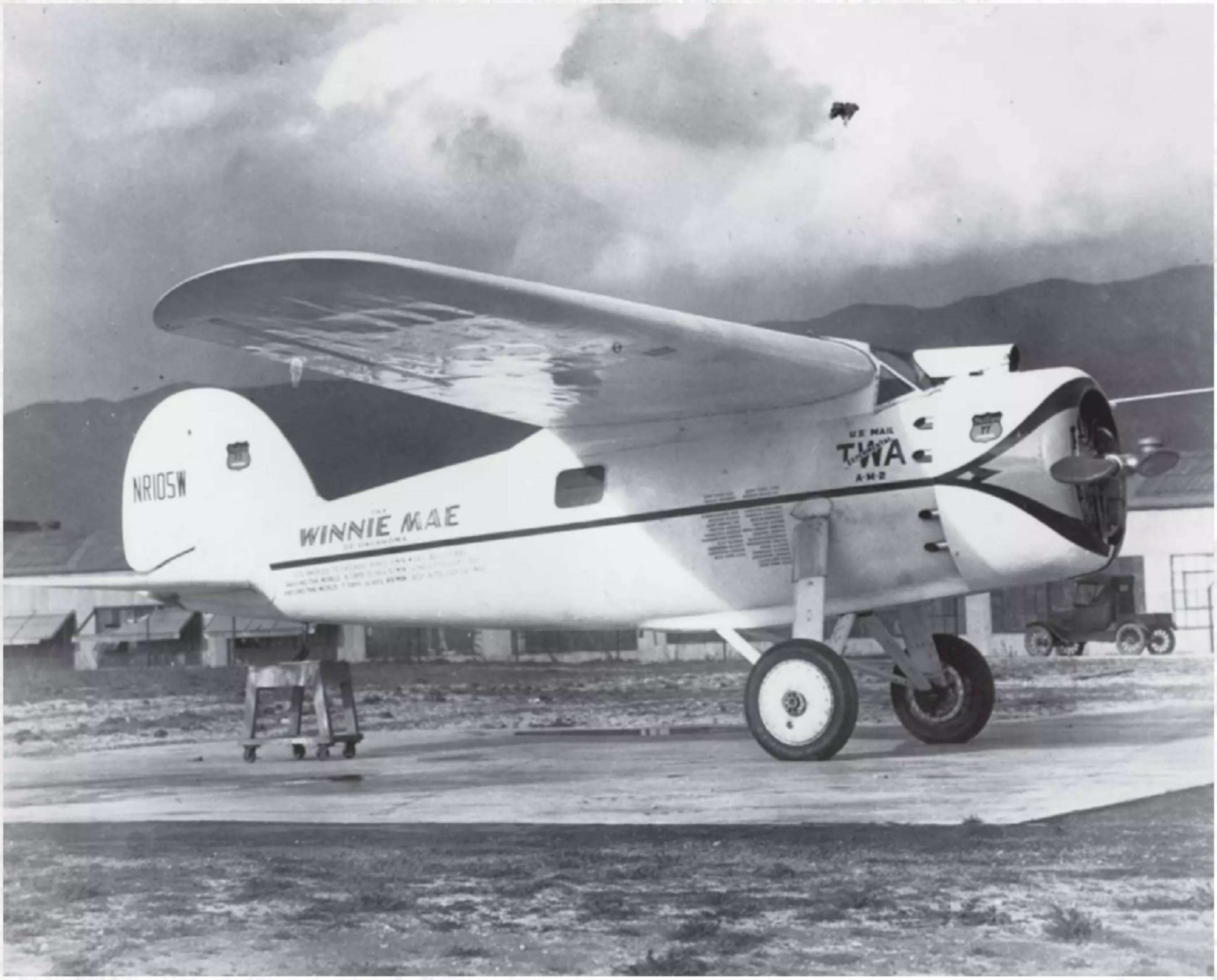
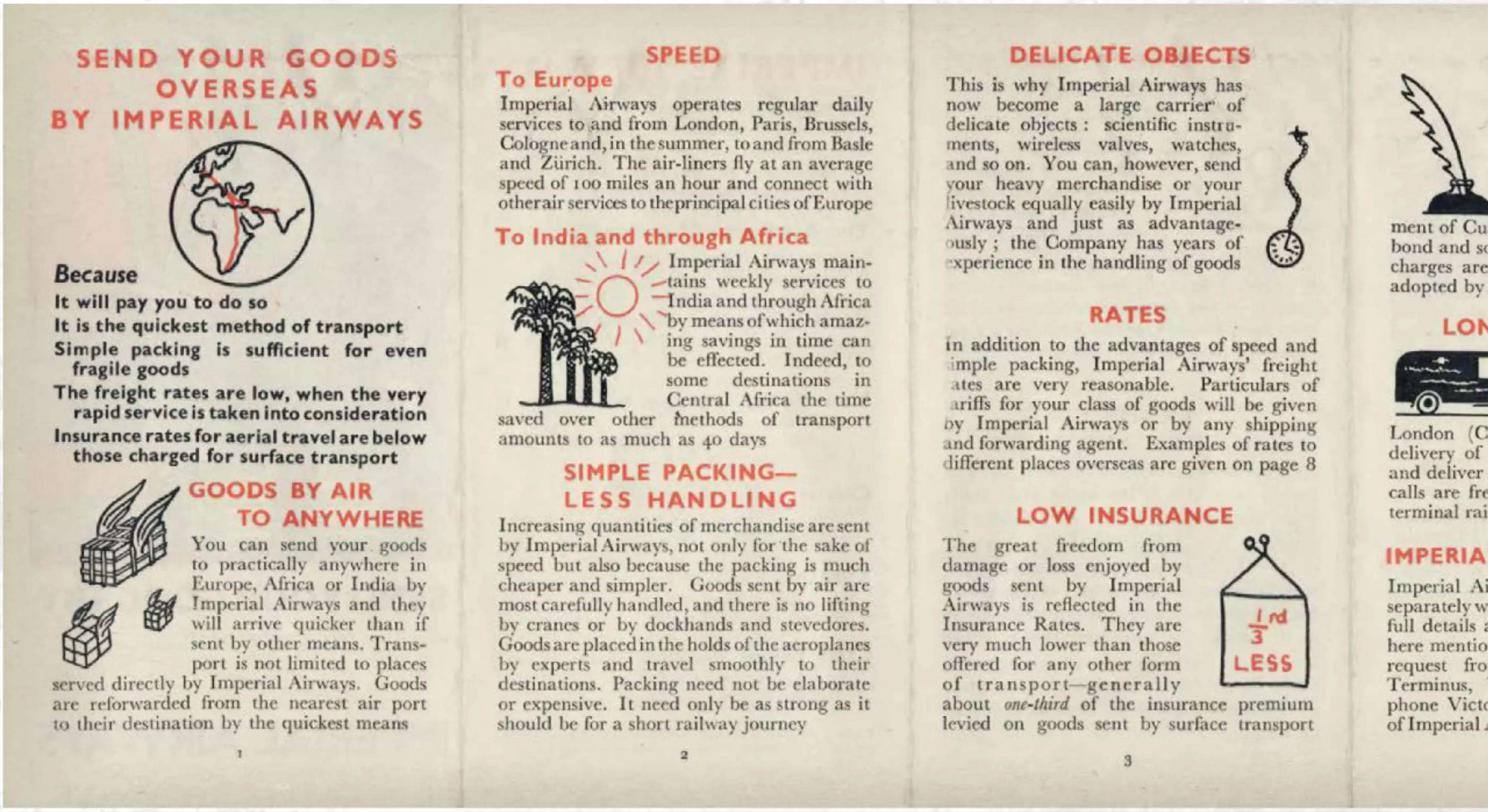
Hélène Bouchier
(1908–1934)

French pilot Hélène Bouchier epitomized the true spirit of 1920s and '30s aviators. Bouchier learnt to fly in 1931 at the age of 23. In February 1933, she set out for to fly from Paris to Saigon but owing to mechanical problems her flight ended in Iraq. The outstanding aerobatic flying skills she demonstrated at the Villacoublay air show later that year brought Bouchier to the attention of the press and drew the admiration of aviation luminaries Jean Mermoz and Antoine de Saint-Exupéry. In August 1934, Bouchier set the woman's world speed record at 444 kilometres per hour (276 miles per hour) in a Caudron CL 450. She was killed during a training flight the following November.

BELOW: American Wiley Post and navigator Harold Gatty circled the globe in eight days and 16 hours in his Lockheed Vega Winnie Mae



Gladys Roy and Ivan Unger play tennis on the upper wings of a Curtiss JN-4 in October 1927. After the First World War, adventurous pilots bought up surplus military aircraft. Known as barnstormers, they travelled across the US thrilling audiences with their displays.



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Imperial Airways maintains weekly services to India and through Africa by means of which amazing savings in time can be effected. Indeed, to some destinations in Central Africa the time saved over other methods of transport amounts to as much as 40 days

SIMPLE PACKING— LESS HANDLING

Increasing quantities of merchandise are sent by Imperial Airways, not only for the sake of speed but also because the packing is much cheaper and simpler. Goods sent by air are most carefully handled, and there is no lifting by cranes or by dockhands and stevedores. Goods are placed in the holds of the aeroplanes by experts and travel smoothly to their destinations. Packing need not be elaborate or expensive. It need only be as strong as it should be for a short railway journey

2

DELICATE OBJECTS

This is why Imperial Airways has now become a large carrier of delicate objects: scientific instruments, wireless valves, watches, and so on. You can, however, send your heavy merchandise or your livestock equally easily by Imperial Airways and just as advantageously; the Company has years of experience in the handling of goods

RATES

In addition to the advantages of speed and simple packing, Imperial Airways' freight rates are very reasonable. Particulars of tariffs for your class of goods will be given by Imperial Airways or by any shipping and forwarding agent. Examples of rates to different places overseas are given on page 8

LOW INSURANCE

The great freedom from damage or loss enjoyed by goods sent by Imperial Airways is reflected in the Insurance Rates. They are very much lower than those offered for any other form of transport—generally about *one-third* of the insurance premium levied on goods sent by surface transport

3

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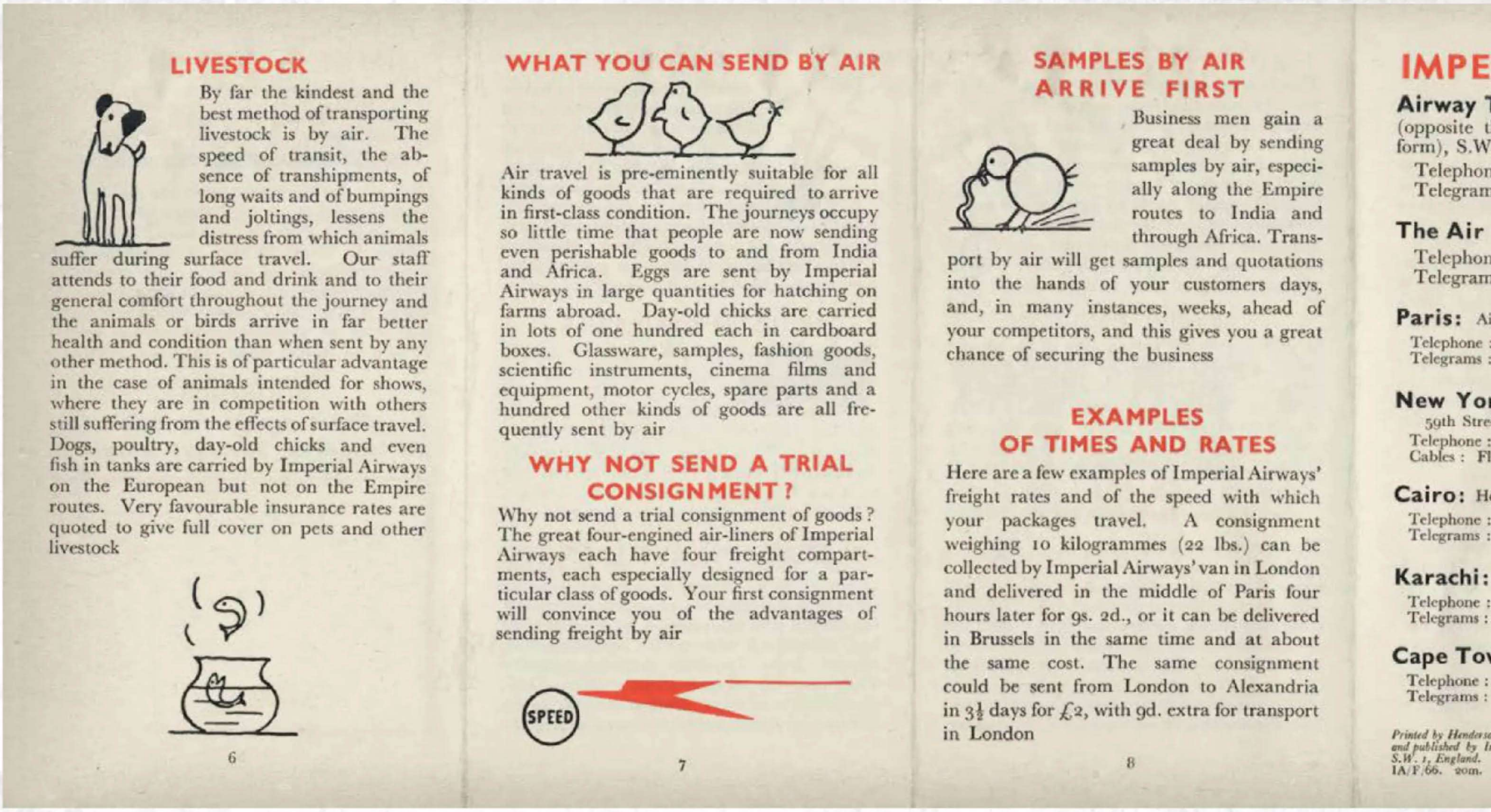

LIVESTOCK

By far the kindest and the best method of transporting livestock is by air. The speed of transit, the absence of transhipments, of long waits and of bumpings and joltings, lessens the distress from which animals suffer during surface travel. Our staff attends to their food and drink and to their general comfort throughout the journey and the animals or birds arrive in far better health and condition than when sent by any other method. This is of particular advantage in the case of animals intended for shows, where they are in competition with others still suffering from the effects of surface travel. Dogs, poultry, day-old chicks and even fish in tanks are carried by Imperial Airways on the European but not on the Empire routes. Very favourable insurance rates are quoted to give full cover on pets and other livestock

6

WHAT YOU CAN SEND BY AIR

Air travel is pre-eminently suitable for all kinds of goods that are required to arrive in first-class condition. The journeys occupy so little time that people are now sending even perishable goods to and from India and Africa. Eggs are sent by Imperial Airways in large quantities for hatching on farms abroad. Day-old chicks are carried in lots of one hundred each in cardboard boxes. Glassware, samples, fashion goods, scientific instruments, cinema films and equipment, motor cycles, spare parts and a hundred other kinds of goods are all frequently sent by air

WHY NOT SEND A TRIAL CONSIGNMENT?

Why not send a trial consignment of goods? The great four-engined air-liners of Imperial Airways each have four freight compartments, each especially designed for a particular class of goods. Your first consignment will convince you of the advantages of sending freight by air

7

SAMPLES BY AIR ARRIVE FIRST

Business men gain a great deal by sending samples by air, especially along the Empire routes to India and through Africa. Transport by air will get samples and quotations into the hands of your customers days, and, in many instances, weeks, ahead of your competitors, and this gives you a great chance of securing the business

EXAMPLES OF TIMES AND RATES

Here are a few examples of Imperial Airways' freight rates and of the speed with which your packages travel. A consignment weighing 10 kilogrammes (22 lbs.) can be collected by Imperial Airways' van in London and delivered in the middle of Paris four hours later for 9s. 2d., or it can be delivered in Brussels in the same time and at about the same cost. The same consignment could be sent from London to Alexandria in 3½ days for £2, with 9d. extra for transport in London

8

IMPE

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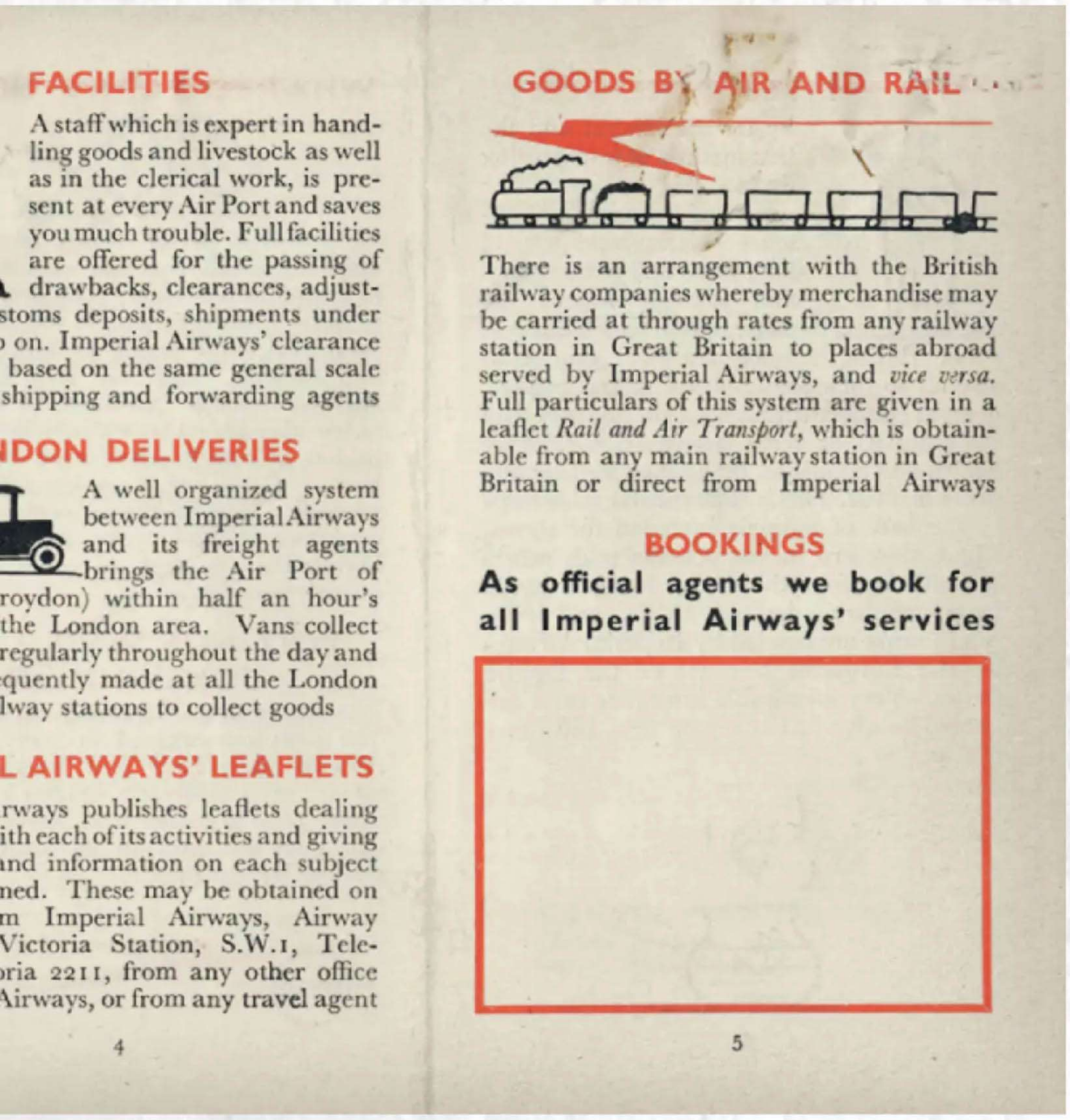


FACILITIES

A staff which is expert in handling goods and livestock as well as in the clerical work, is present at every Air Port and saves you much trouble. Full facilities are offered for the passing of drawbacks, clearances, adjust- stoms deposits, shipments under o on. Imperial Airways' clearance based on the same general scale shipping and forwarding agents

NDON DELIVERIES

A well organized system between Imperial Airways and its freight agents brings the Air Port of roydon) within half an hour's the London area. Vans collect regularly throughout the day and quently made at all the London lway stations to collect goods

L AIRWAYS' LEAFLETS

rways publishes leaflets dealing ith each of its activities and giving and information on each subject ned. These may be obtained on m Imperial Airways, Airway Victoria Station, S.W.1, Tele- oria 2211, from any other office Airways, or from any travel agent

4

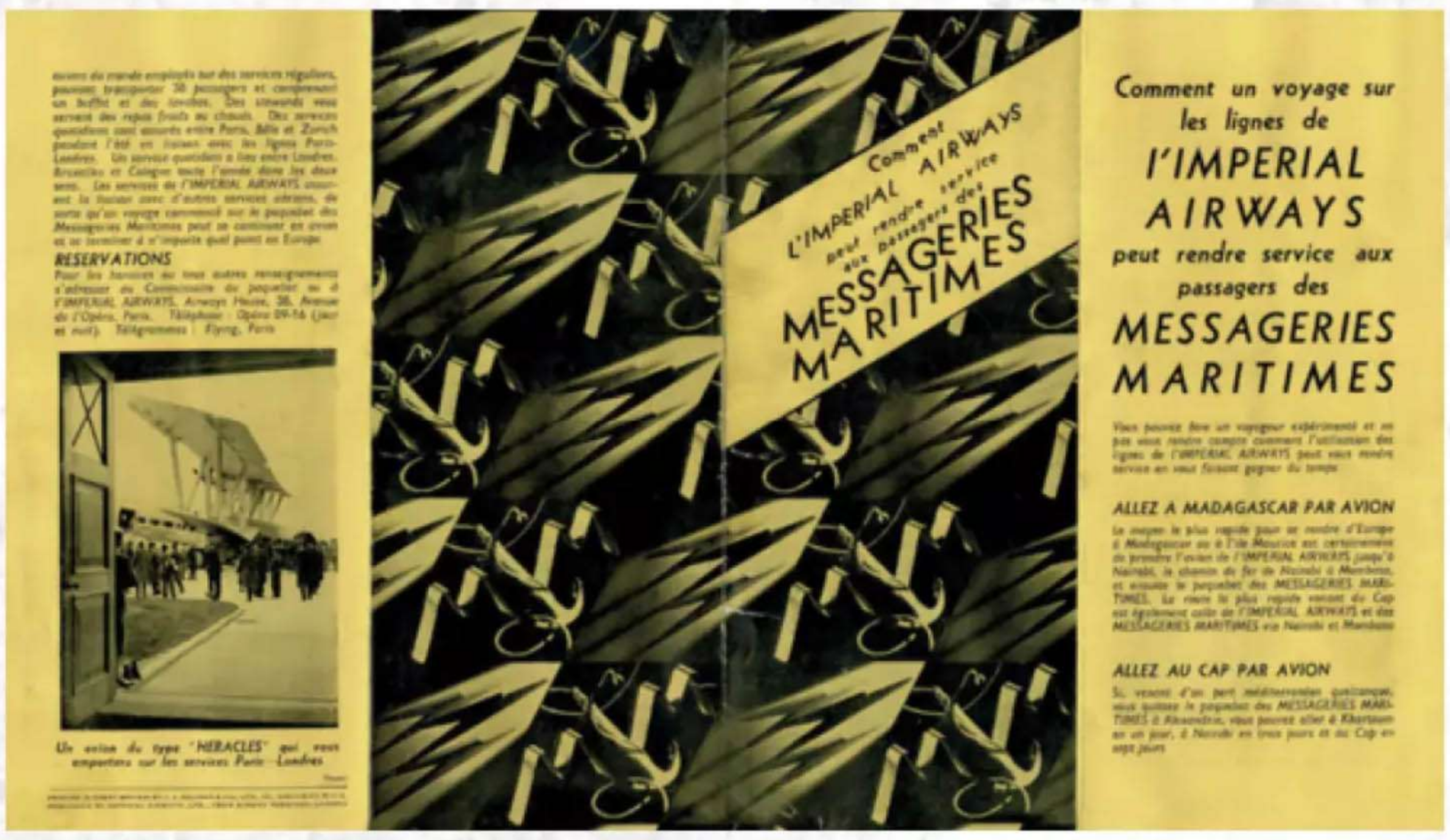
GOODS BY AIR AND RAIL

There is an arrangement with the British railway companies whereby merchandise may be carried at through rates from any railway station in Great Britain to places abroad served by Imperial Airways, and *vice versa.* Full particulars of this system are given in a leaflet *Rail and Air Transport*, which is obtainable from any main railway station in Great Britain or direct from Imperial Airways

BOOKINGS

As official agents we book for all Imperial Airways' services

5



RESERVATIONS

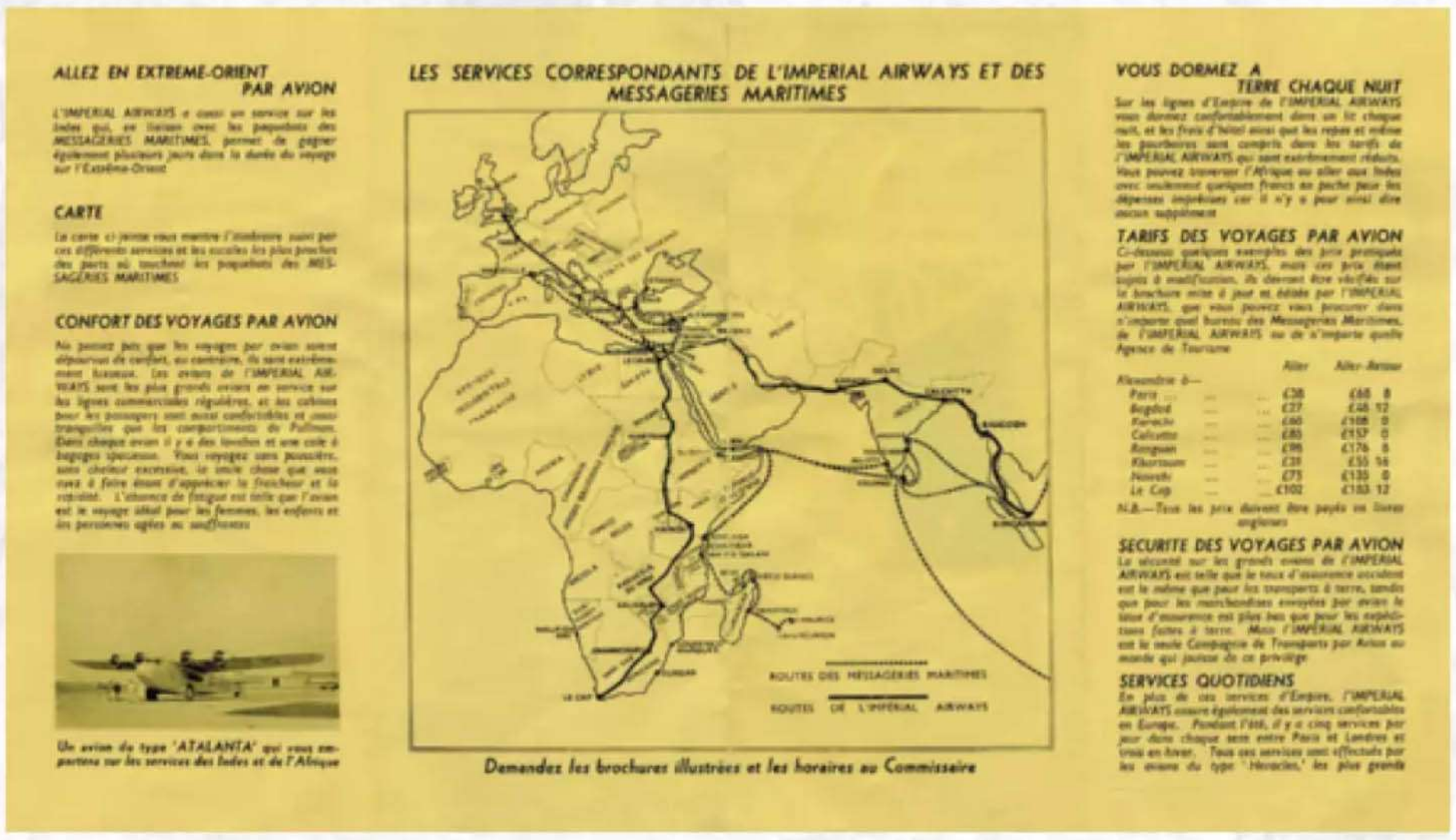
Un avion du type 'HERACLES' qui vous emportera sur les services Paris—Londres

Comment L'IMPERIAL AIRWAYS peut rendre service aux passagers des MESSAGERIES MARITIMES

Comment un voyage sur les lignes de
l'IMPERIAL AIRWAYS
peut rendre service aux passagers des
MESSAGERIES MARITIMES

ALLEZ A MADAGASCAR PAR AVION

ALLEZ AU CAP PAR AVION



ALLEZ EN EXTREME-ORIENT PAR AVION

CARTE

CONFORT DES VOYAGES PAR AVION

Un avion du type 'ATALANTA' qui vous emportera sur les services des Indes et de l'Afrique

LES SERVICES CORRESPONDANTS DE L'IMPERIAL AIRWAYS ET DES MESSAGERIES MARITIMES

ROUTES DES MESSAGERIES MARITIMES
ROUTES DE L'IMPERIAL AIRWAYS

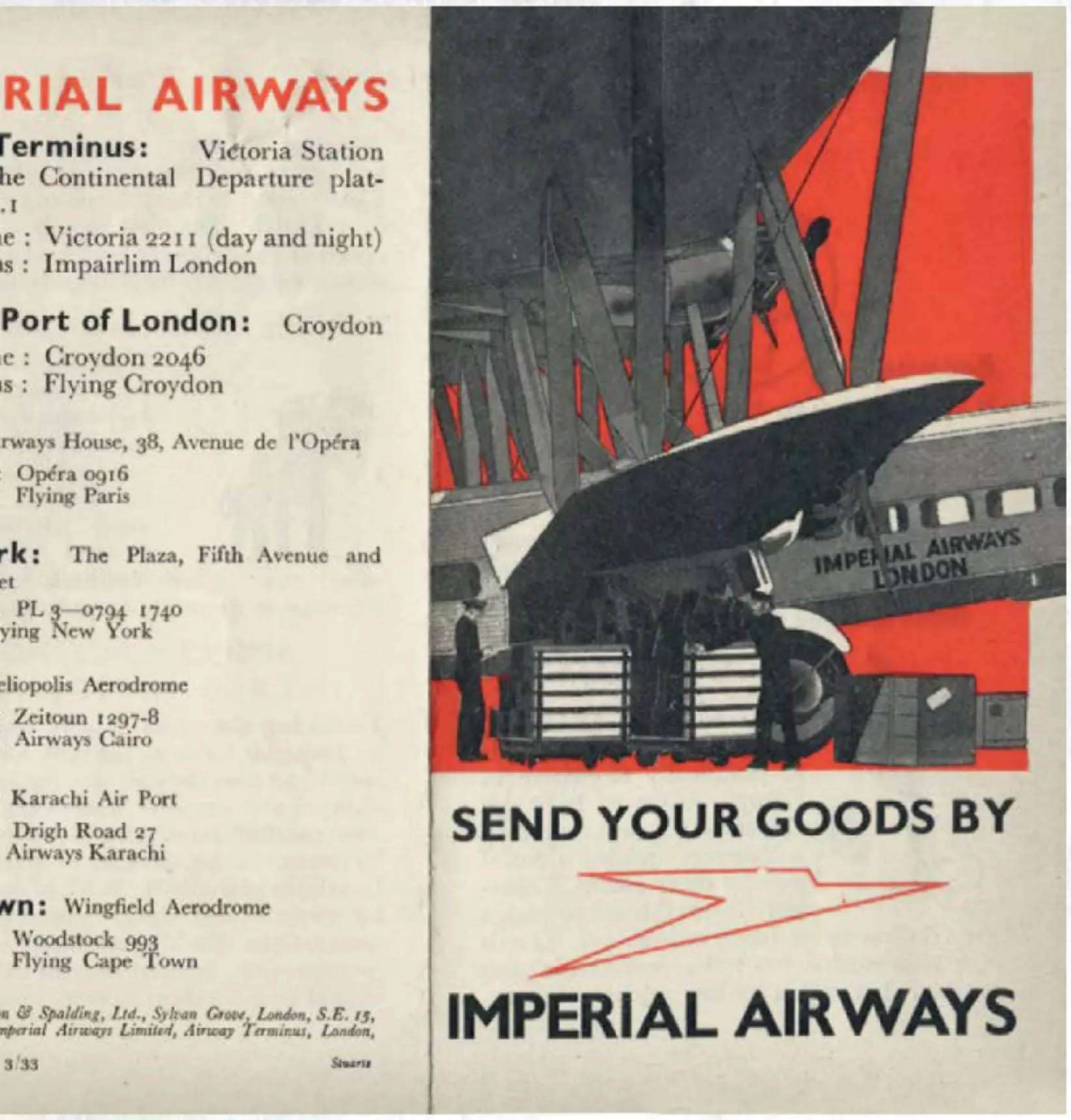
Demandez les brochures illustrées et les horaires au Commissaire

VOUS DORMEZ A TERRE CHAQUE NUIT

TARIFS DES VOYAGES PAR AVION

SECURITE DES VOYAGES PAR AVION

SERVICES QUOTIDIENS



RIAL AIRWAYS

Terminus: Victoria Station
he Continental Departure plat-
.1
e : Victoria 2211 (day and night)
s : Impairlim London

Port of London: Croydon
e : Croydon 2046
s : Flying Croydon

rways House, 38, Avenue de l'Opéra
Opéra 0916
Flying Paris

rk: The Plaza, Fifth Avenue and
et
PL 3—0794 1740
ying New York

eliopolis Aerodrome
Zeitoun 1297-8
Airways Cairo

Karachi Air Port
Drigh Road 27
Airways Karachi

wn: Wingfield Aerodrome
Woodstock 993
Flying Cape Town

n & Spalding, Ltd., Sylvan Grove, London, S.E. 15,
nperial Airways Limited, Airway Terminus, London,

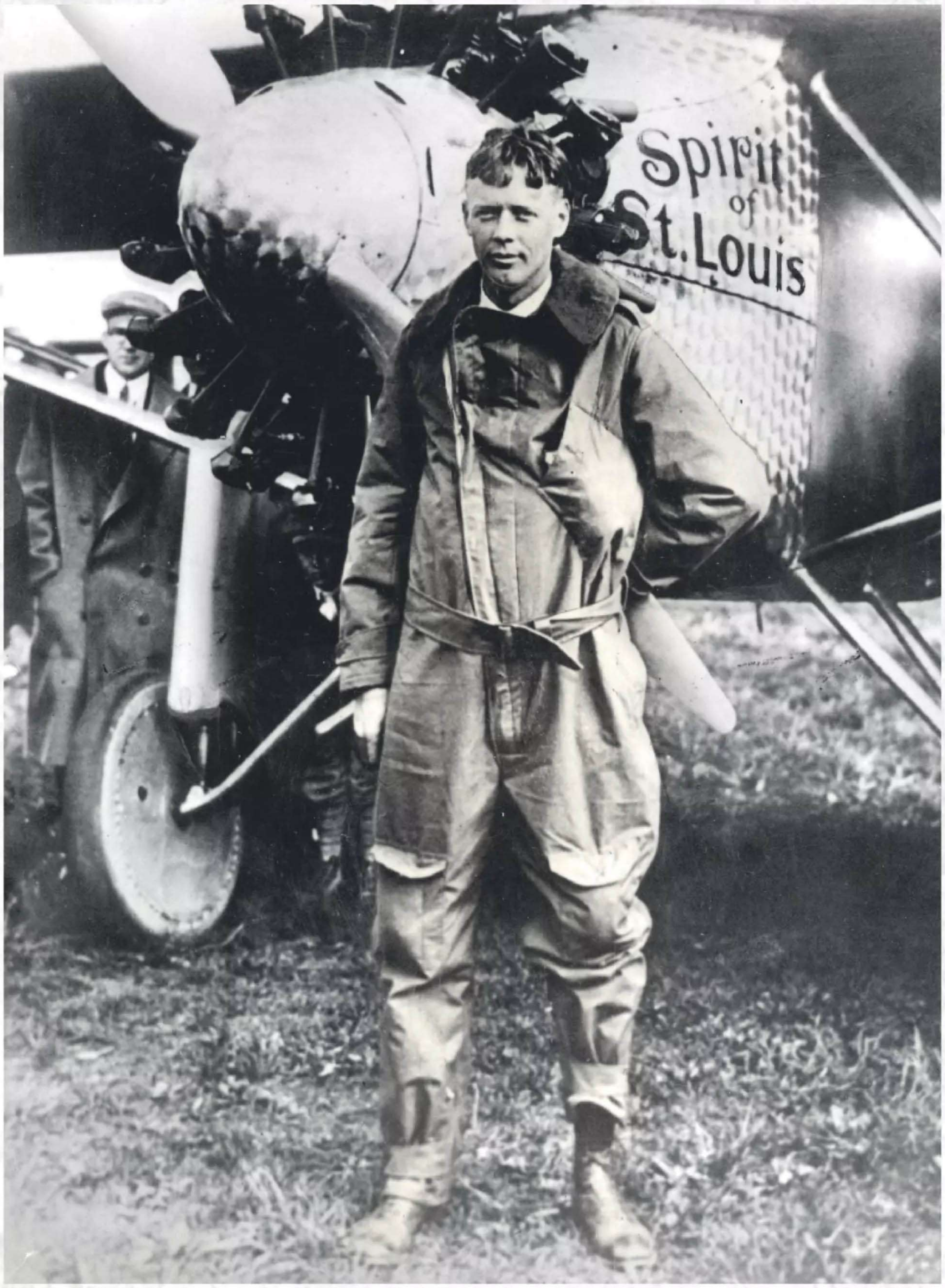
3/33 Stuarts

deaden the sound of the engines, they were also extremely noisy. European airlines, developed with government subsidies and through mergers, began to grow into national airlines. Foremost amongst these was the German airline Lufthansa which in the 1930s was the world's largest, responsible for some 40 percent of global passenger air traffic. The French government subsidized a number of airlines which eventually became the state airline, Air France, in 1933. The British financed Imperial Airways became part of BOAC (British Overseas Airways Corporation) in 1939. With no state subsidies, airline development in America had to wait for the stimulus afforded by the privatization of the US Air Mail network in 1925.

OPPOSITE AND ABOVE: An Imperial Airways brochure promoting links between its African and Asian routes and those of the boat/train services of the French shipping line Messageries Maritime.

NEW YORK TO PARIS NON-STOP

Inspired by Alcock and Brown's transatlantic flight of 1919, French-born New York hotelier Raymond Orteig offered a $25,000 prize for the first flight from Paris to New York or New York to Paris, but it was not until the late 1920s that aircraft and aero engines capable of making the flight became available.



Charles Lindbergh was one of a number of entrants for the Orteig prize. He differed from the other competitors in that he opted to fly alone and in a single-engine aircraft called the Spirit of St Louis which was built to Lindbergh's specifications by the Ryan Aeronautical Company. It was powered by one of a new generation of very reliable engines; the radial Wright Whirlwind J-5C. Lindbergh took off from Roosevelt Field near New York at 7.52 a.m. on 20 May 1927. During his flight he encountered fog, storms, high-towering clouds and icy conditions. Fatigue was his biggest problem; he could not fall asleep for a moment as his aircraft was so unstable that it had to be controlled at all times, but he landed safely at Le Bourget, Paris, at 10.21 p.m. local time (5.21 p.m. New York time) on 21 May where he was greeted by some 100,000 people. He had flown more than 5,800 kilometres (3,600 miles) in 33-and-a-half hours. On 29 May he flew to Croydon, London and was met by a crowd of 150,000. Lindbergh's flight instantly shot him from obscurity to stardom; suddenly he was the most famous man in the world. On his return to the United States he was given a ticker-tape parade in front of three million New Yorkers and received a million telegrams and half a million letters, not to mention several thousand offers of marriage!

LEFT: Charles Lindbergh with his aircraft Spirit of St Louis before his flight from New York to Paris on 1 May 1927. Lindbergh's career prior to 1927, which included studying engineering at university, barnstorming, flying with the Army Air Service Reserve and serving as an airmail pilot, ensured that he was well prepared to meet the challenges of the flight.

OPPOSITE: Lindbergh's Spirit of St Louis in flight. The aircraft was a specially commissioned modified Ryan NYP monoplane with an increased wingspan and the engine further forward than in the original design, so that a large fuel tank could be installed. Lindbergh was supported by a group of St Louis businessmen, to whom the aircraft owed its name.

Charles Lindbergh
(1902–1974)

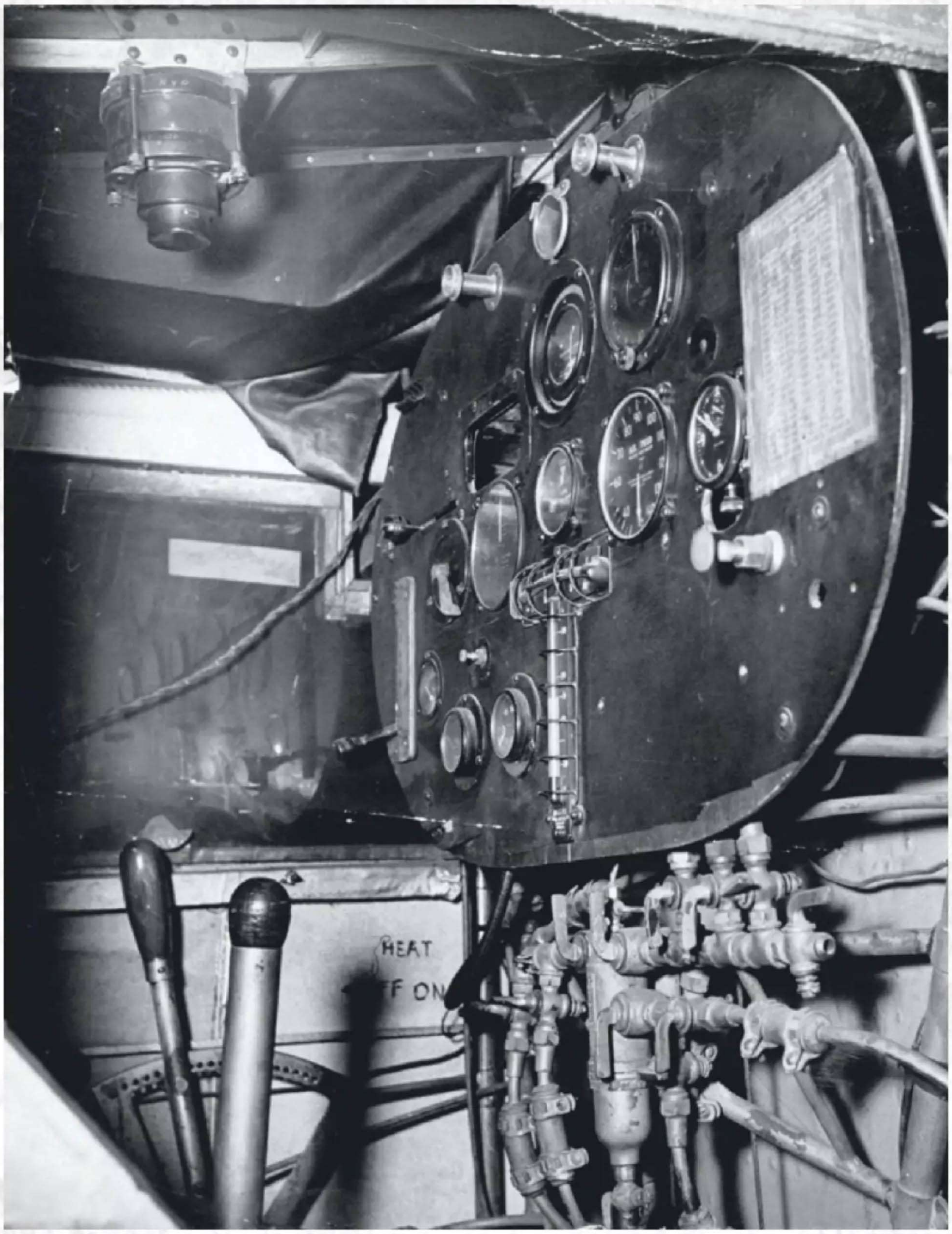
Charles Lindbergh's 1927 first transatlantic solo flight made him internationally famous. The press named him "Lucky Lindy" and the "Lone Eagle". Showered with honours and idolised by millions, he was one of the twentieth century's first celebrities. In the late 1920s and 1930s he helped to promote the rapid development of US commercial aviation. He was opposed to US entry into the Second World War but after Pearl Harbor he worked and flew in combat as a civilian advisor. After the war he advised Pan Am on jet aircraft, including the Boeing 747. His book The Spirit of St Louis won a Pulitzer Prize in 1954.

Spirit
St Louis

Other contenders for the Orteig Prize were not so fortunate. Flights prior to Lindbergh's took the lives of six aviators including the Frenchmen Charles Nungesser and François Colli. They took off from Paris on 7 May 1927 but after crossing the French coast, were never seen again. However, a little more than a week after Lindbergh's flight, Clarence Chamberlain and Charles Levine successfully set a world distance record by flying between New York and Eisenben, Germany. On 1 July 1927, Richard Byrd and the crew of America flew as far as Paris but their attempts to land were frustrated by bad weather, leading them to ditch off the French coast after a flight of over 43 hours. Byrd and his crew survived but out of ten flyers involved in transatlantic attempts in the following two months, only two made it safely.

Flying across the Atlantic remained the great challenge for aviators during the 1930s. British pilot Jim Mollison made the first solo westward North Atlantic flight in 1932 in the de Havilland Puss Moth Hearts Content and made the first solo westward flight across the South Atlantic in the same aircraft in 1933. He flew the Atlantic again in that year together with his wife Amy Johnson, but the honour of being the first woman to fly across the Atlantic had already gone to Amelia Earhart in 1928 when she flew as a passenger with Wilmer Stultz and Lew Gordon in the Friendship, a Fokker FVIIB-3m. Four years later she returned to the Atlantic and made the first solo flight by a woman in a Lockheed Vega Gull.

Lindbergh's flight and those of other the transatlantic pioneers were great personal triumphs but they also served to focus public attention on aviation and its great potential for personal transportation. Lindbergh's flight in particular, provoked huge interest in aviation in the United States and marked a revival in the fortunes of its struggling aircraft and air transport businesses.



LEFT: The cramped cockpit of the Spirit of St Louis. With the fuel tank placed behind the engine, Lindbergh had no forward window so he either used a periscope or turned the aircraft in order to look out of the side windows.

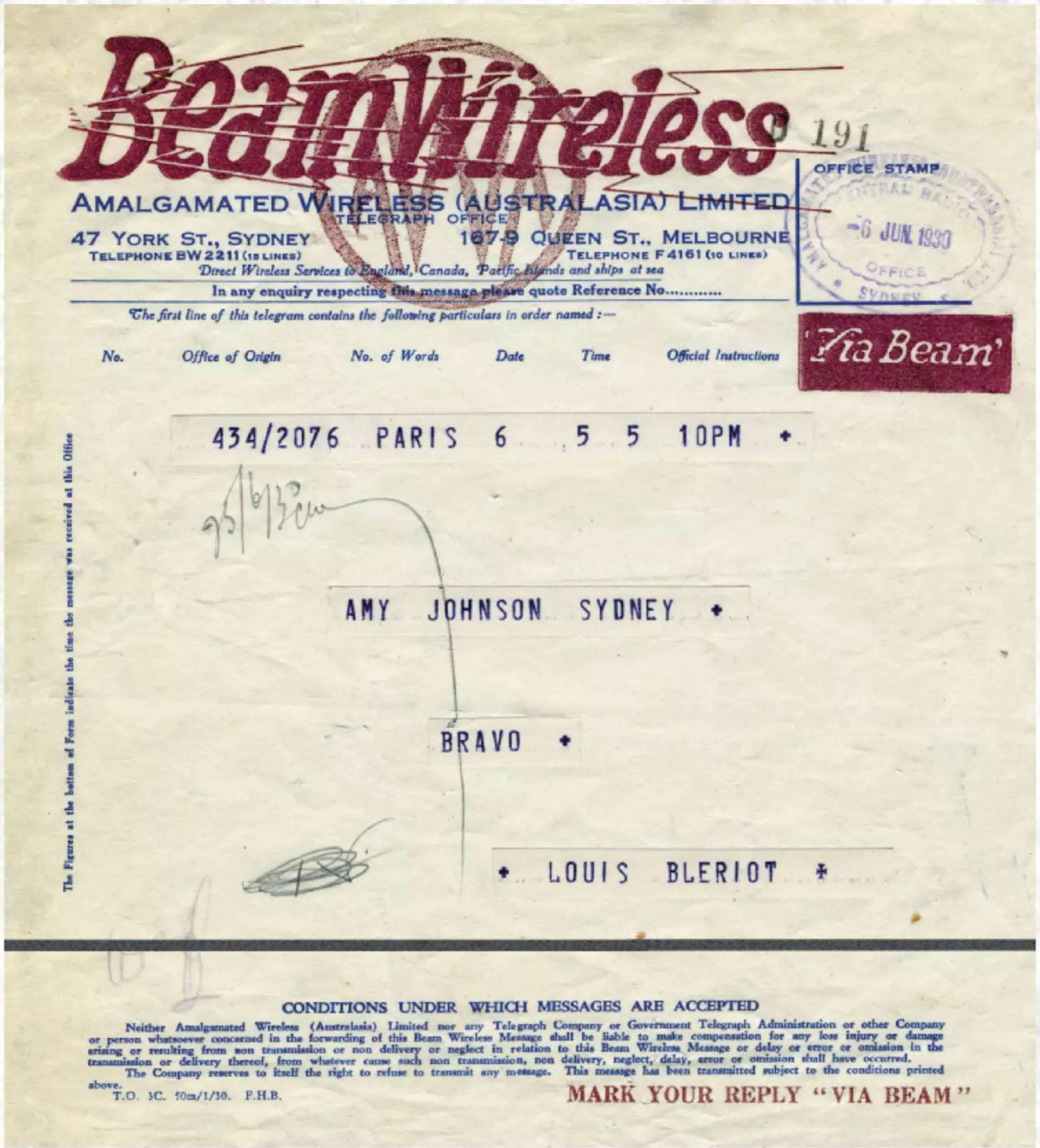
OPPOSITE, ABOVE LEFT: Amy Johnson kissing her husband Jim Mollison goodbye before his flight across the south Atlantic in 1933. The couple, together and singly, made many record-breaking flights in the 1930s. Amy Johnson died while flying with the British Air Transport Auxiliary in 1941.

OPPOSITE, RIGHT ABOVE AND BELOW: Congratulatory message from Louis Blériot, and from Charles and Anne Lindbergh to Amy Johnson after she became the first woman to fly solo from Britain to Australia in May 1930.

OPPOSITE, BELOW LEFT: Amelia Earhart; the first woman to cross the Atlantic by aeroplane in June 1928. Earhart and her navigator Fred Noonan disappeared over the Pacific during a round-the-world flight in 1937.

James Mollison
(1905–1959)

Scotsman "Jim" Mollison set many aviation records in the 1930s. He learnt to fly at RAF Duxford and when he obtained his commission in the RAF at the age of 18 he was the youngest officer in the service. On leaving the RAF he set out to make his name in civil aviation. Long distance flying was a way of doing this and in 1931 and 1932 he set record times for flights to Australia and South Africa. He met and married the famous aviator Amy Johnson, in 1932. Mollison made the first west to east transatlantic flights against the much more challenging prevailing winds in 1932 and 1933.



Beam Wireless 191

AMALGAMATED WIRELESS (AUSTRALASIA) LIMITED
TELEGRAPH OFFICE
47 YORK ST., SYDNEY
TELEPHONE BW 2211 (15 LINES)
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Direct Wireless Services to England, Canada, Pacific Islands and ships at sea

In any enquiry respecting this message please quote Reference No............

OFFICE STAMP
-6 JUN 1930
OFFICE
SYDNEY

The first line of this telegram contains the following particulars in order named:—

No.	Office of Origin	No. of Words	Date	Time	Official Instructions
434/2076	PARIS	6	5 5	10PM	

'Via Beam'

AMY JOHNSON SYDNEY

BRAVO

LOUIS BLERIOT

The Figures at the bottom of Form indicate the time the message was received at this Office

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T.O. 3C. 50m/1/30. P.H.B.

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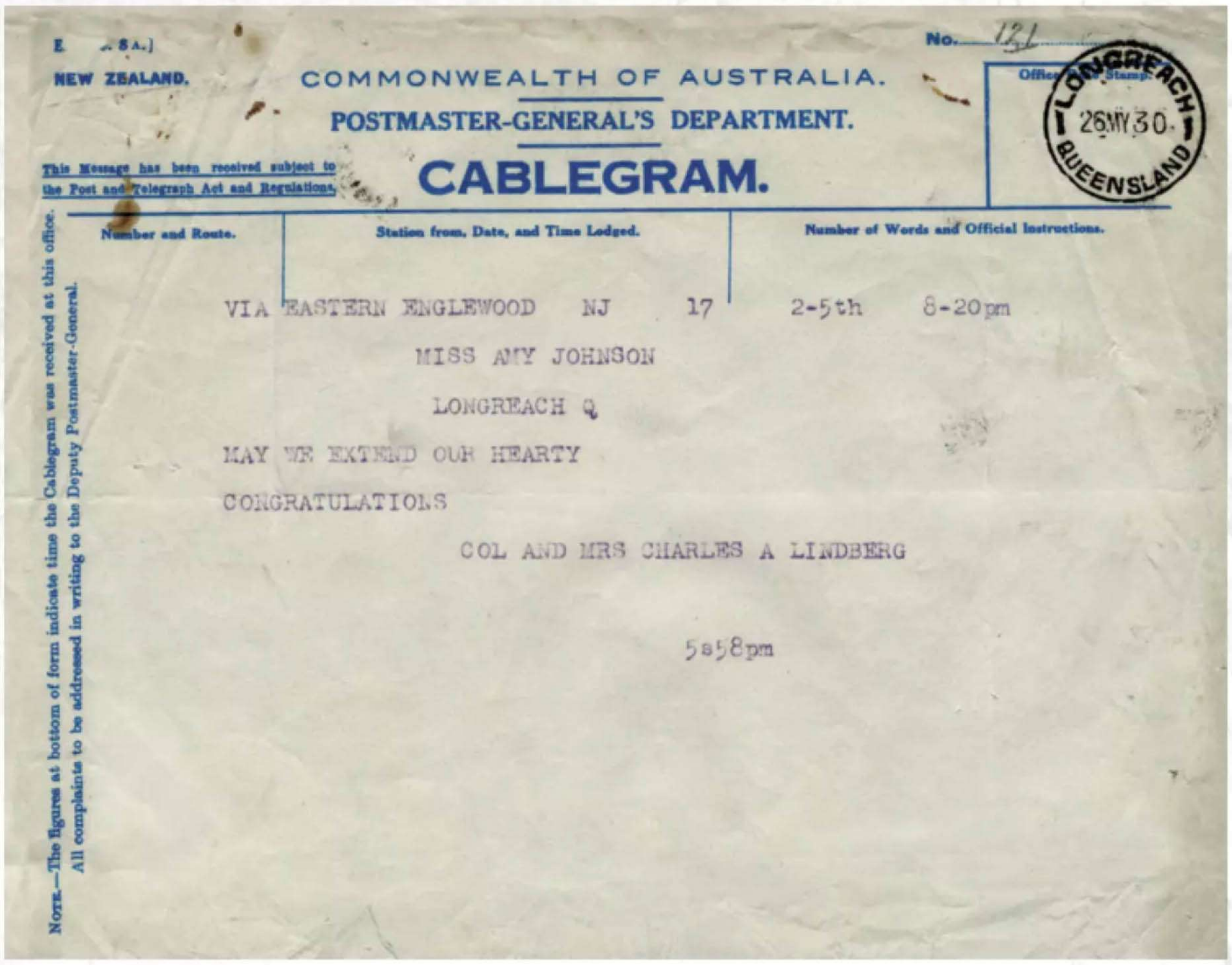


E. 8A.]
NEW ZEALAND.

COMMONWEALTH OF AUSTRALIA.
POSTMASTER-GENERAL'S DEPARTMENT.
CABLEGRAM.

No. 121

Office Date Stamp.
LONGREACH
26 MY 30
QUEENSLAND

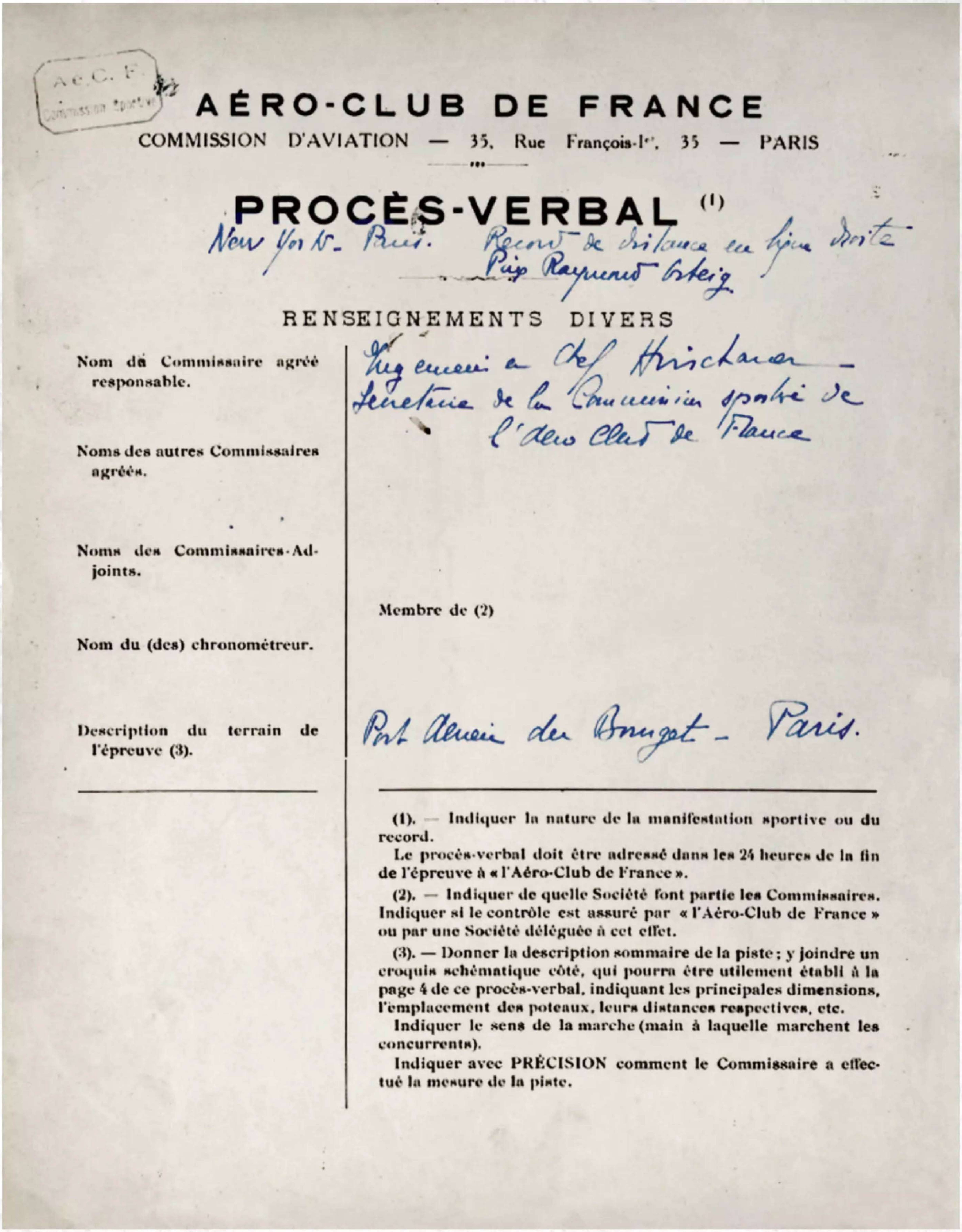
This Message has been received subject to the Post and Telegraph Act and Regulations.

Number and Route.	Station from, Date, and Time Lodged.	Number of Words and Official Instructions.
VIA	EASTERN ENGLEWOOD NJ	17 2-5th 8-20pm

MISS AMY JOHNSON
LONGREACH Q
MAY WE EXTEND OUR HEARTY
CONGRATULATIONS
COL AND MRS CHARLES A LINDBERG

5s58pm

NOTE.—The figures at bottom of form indicate time the Cablegram was received at this office.
All complaints to be addressed in writing to the Deputy Postmaster-General.



Ae.C.F.
Commission Sportive

AÉRO-CLUB DE FRANCE

COMMISSION D'AVIATION — 35, Rue François-Ier, 35 — PARIS

PROCÈS-VERBAL (1)

New York - Paris. Record de distance en ligne droite
Prix Raymond Orteig

RENSEIGNEMENTS DIVERS

Nom du Commissaire agréé responsable. Ingénieur en Chef Hirschauer - Secrétaire de la Commission sportive de l'Aéro Club de France

Noms des autres Commissaires agréés.

Noms des Commissaires-Adjoints.

Membre de (2)

Nom du (des) chronométreur.

Description du terrain de l'épreuve (3). Port Aérien du Bourget - Paris.

---

(1). — Indiquer la nature de la manifestation sportive ou du record.

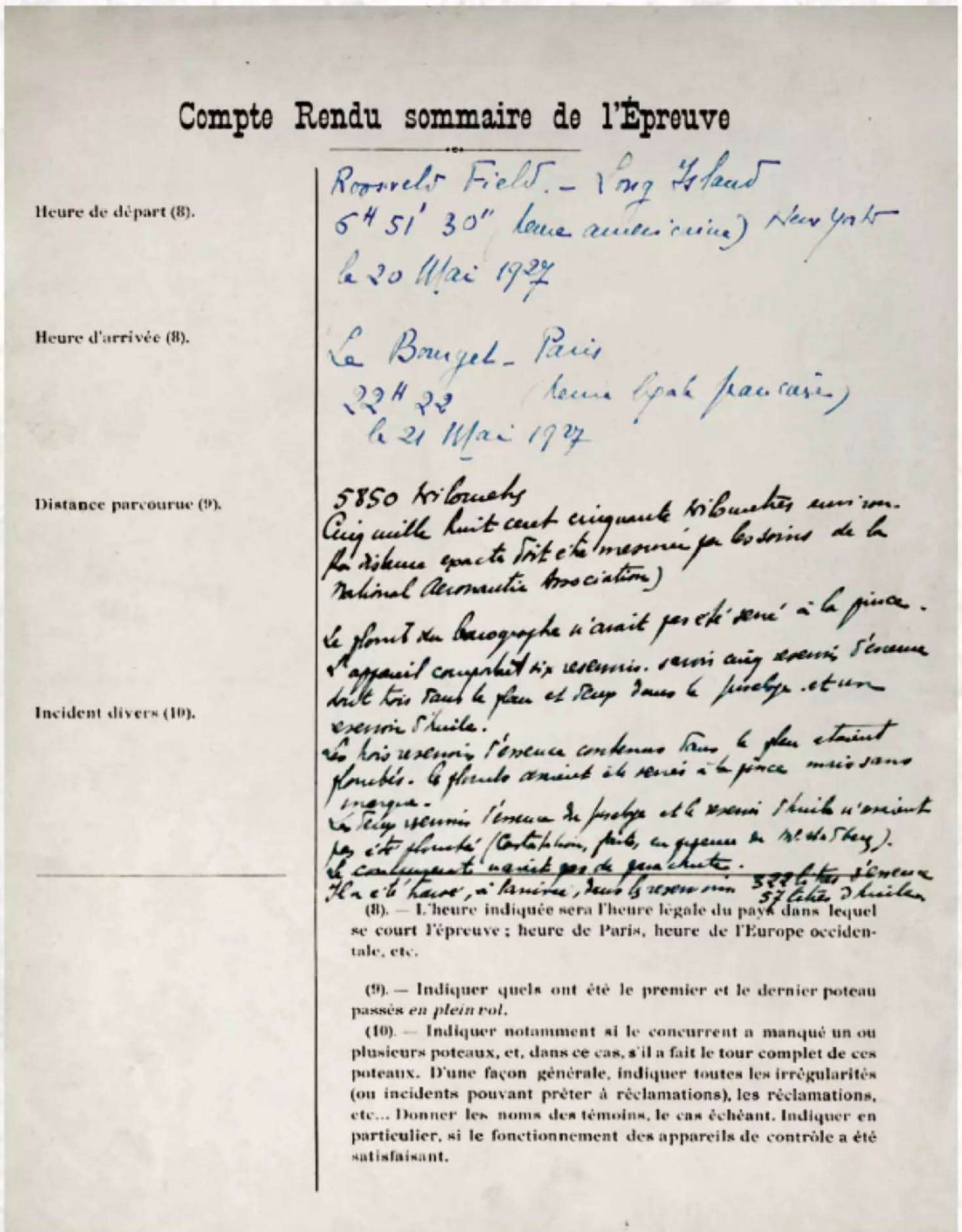
Le procès-verbal doit être adressé dans les 24 heures de la fin de l'épreuve à « l'Aéro-Club de France ».

(2). — Indiquer de quelle Société font partie les Commissaires. Indiquer si le contrôle est assuré par « l'Aéro-Club de France » ou par une Société déléguée à cet effet.

(3). — Donner la description sommaire de la piste ; y joindre un croquis schématique côté, qui pourra être utilement établi à la page 4 de ce procès-verbal, indiquant les principales dimensions, l'emplacement des poteaux, leurs distances respectives, etc.

Indiquer le sens de la marche (main à laquelle marchent les concurrents).

Indiquer avec PRÉCISION comment le Commissaire a effectué la mesure de la piste.



Compte Rendu sommaire de l'Épreuve

Heure de départ (8). Roosevelt Field. – Long Island
6H 51' 30" (heure américaine) New York
le 20 Mai 1927

Heure d'arrivée (8). Le Bourget – Paris
22H 22 (heure légale française)
le 21 Mai 1927

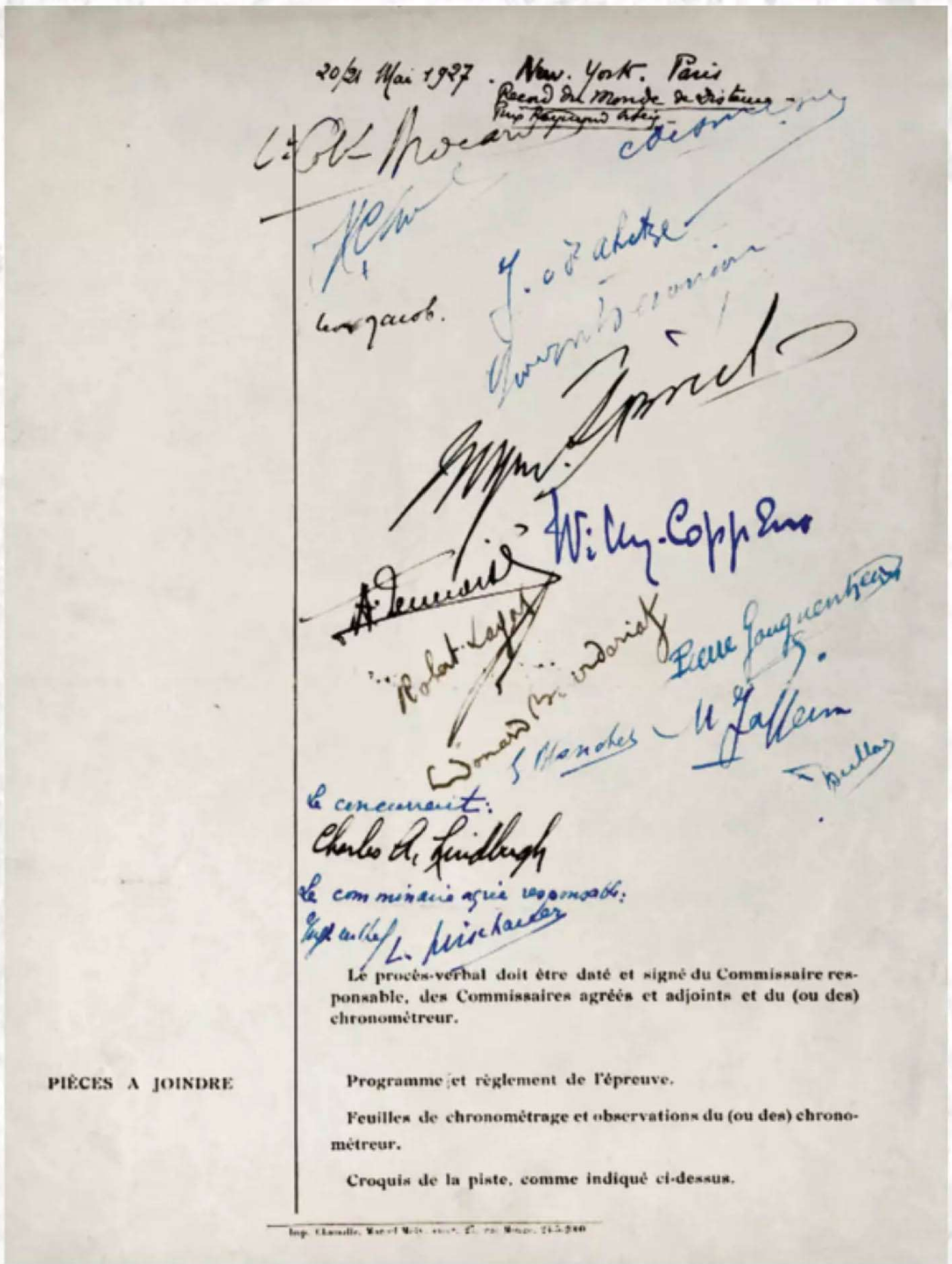
Distance parcourue (9). 5850 kilomètres
Cinq mille huit cent cinquante kilomètres environ.
(La distance exacte doit être mesurée par les soins de la National Aeronautic Association)

Incident divers (10). Le plomb du barographe n'avait pas été serré à la pince.
L'appareil comportait six réservoirs. savoir cinq réservoirs d'essence dont trois dans le plan et deux dans le fuselage. et un réservoir d'huile.
Les trois réservoirs d'essence contenus dans le plan étaient plombés. Les plombs avaient été serrés à la pince mais sans marque.
Les deux réservoirs d'essence du fuselage et le réservoir d'huile n'avaient pas été plombés (Constatation faite en présence de M. [illegible]).
Le concurrent n'avait pas de parachute.
Il a été trouvé, à l'arrivée, dans les réservoirs 322 litres d'essence 57 litres d'huile

(8). — L'heure indiquée sera l'heure légale du pays dans lequel se court l'épreuve ; heure de Paris, heure de l'Europe occidentale, etc.

(9). — Indiquer quels ont été le premier et le dernier poteau passés *en plein vol*.

(10). — Indiquer notamment si le concurrent a manqué un ou plusieurs poteaux, et, dans ce cas, s'il a fait le tour complet de ces poteaux. D'une façon générale, indiquer toutes les irrégularités (ou incidents pouvant prêter à réclamations), les réclamations, etc... Donner les noms des témoins, le cas échéant. Indiquer en particulier, si le fonctionnement des appareils de contrôle a été satisfaisant.



20/21 Mai 1927. New York. Paris
Record du Monde de distance
Prix Raymond Orteig

Willy-Coppens

le concurrent:
Charles A. Lindbergh

le commissaire agréé responsable:
L. [illegible]

Le procès-verbal doit être daté et signé du Commissaire responsable, des Commissaires agréés et adjoints et du (ou des) chronométreur.

PIÈCES A JOINDRE

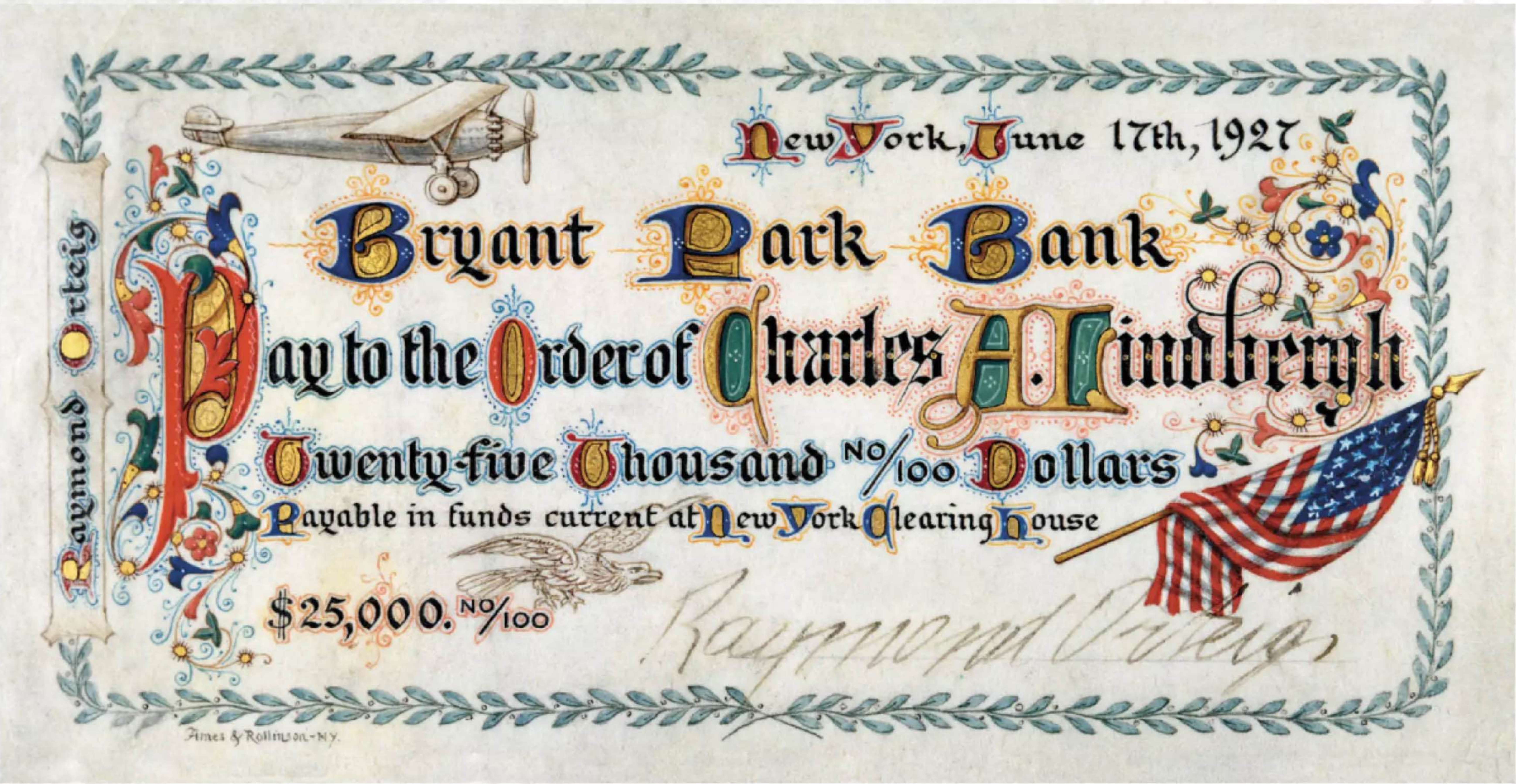
Programme et règlement de l'épreuve.

Feuilles de chronométrage et observations du (ou des) chronométreur.

Croquis de la piste, comme indiqué ci-dessus.

OPPOSITE AND ABOVE: The official report issued by the Aéro-Club de France recording Charles Lindbergh's record-breaking transatlantic flight from New York to Paris in 1927.

BELOW: The $25,000 Raymond Orteig prize won by Charles Lindbergh for the first non-stop flight from Paris to New York in 1927.



Raymond Orteig

New York, June 17th, 1927

Bryant Park Bank

Pay to the Order of Charles A. Lindbergh

Twenty-five Thousand No/100 Dollars

Payable in funds current at New York Clearing House

$25,000. No/100

Raymond Orteig

Ames & Rollinson - NY.

AIRSHIPS AND FLYING BOATS

After the R 34's transatlantic flights in 1919, many people believed that airships offered the best option for long-distance passenger flights. Although the German Zeppelin company had considerable experience in building and operating airships, restrictions set in place by the post-First World War treaties made it difficult for the company to operate until, under the inspired leadership of Hugo Eckener, it succeeded in winning a contract in 1922 to build the USS Los Angeles for the US Navy. Zeppelin formed an alliance with the American company Goodyear, producing two further airships for the US Navy, both of which were later lost over the sea.

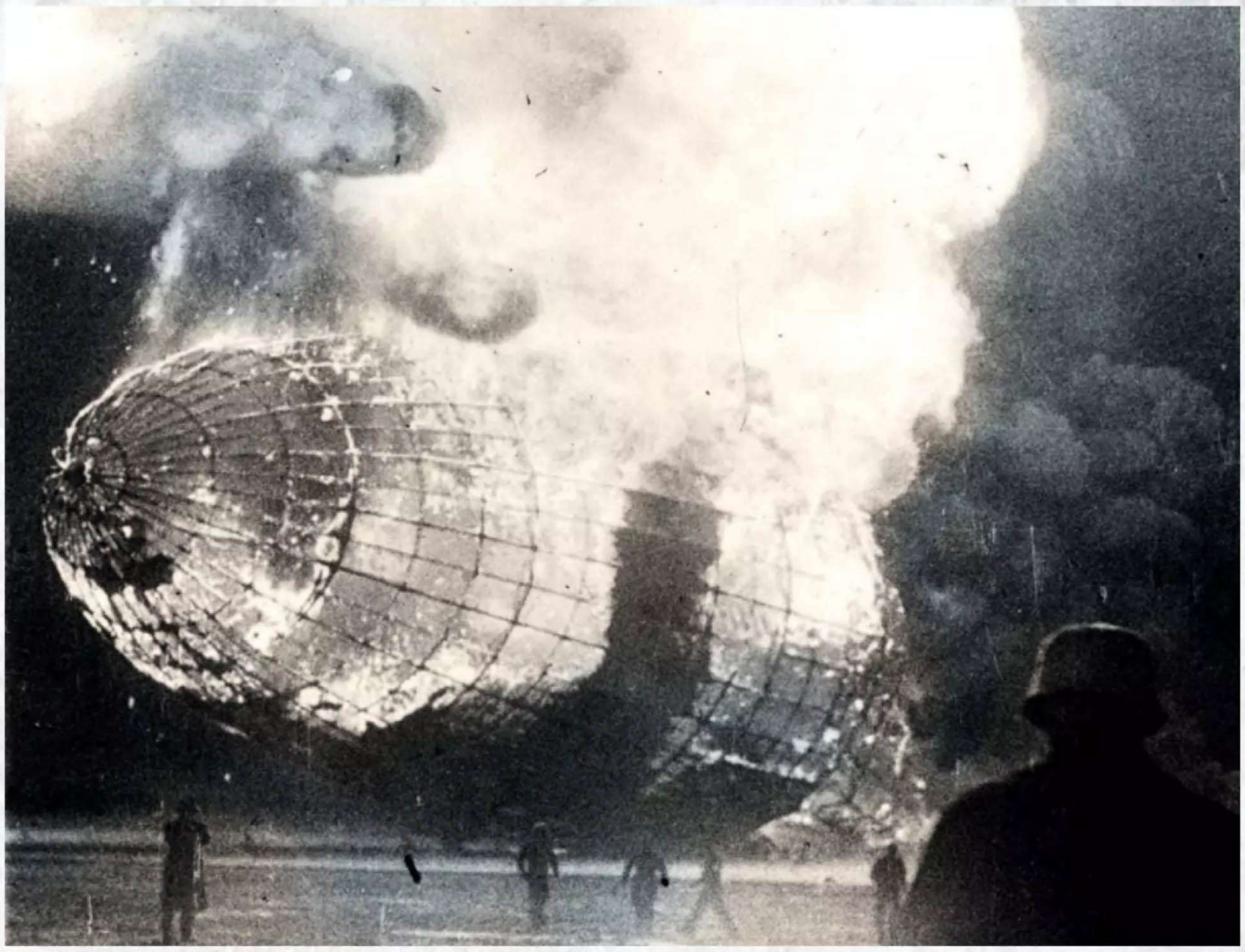
In the late 1920s, Britain created two large airships, the R 100 and the R 101 for use on routes to Canada, India and Australia. The R 100, designed by Barnes Wallis and built by Vickers, made a successful inaugural flight to Canada in 1930 but after the loss of the R 101, which crashed in France on a flight headed for India in October 1930, R 100 was scrapped and Britain abandoned the concept for good. With both French and Italian craft suffering similar fates, only the Germans retained their faith in airships.

Their confidence appeared to be vindicated by the launch of the Graf Zeppelin in September 1928. Her flight from Germany to New York the next month saw the beginning of a successful ten-year career. Her trips across the Atlantic, to South America in particular, constituted the only long-range passenger air service at that time. Graf Zeppelin's successor, the Hindenburg was designed to carry 50 passengers in luxury across the North Atlantic. At 245 metres (803 feet) long and with a maximum diameter of 41 metres (135 feet), the Hindenburg was the biggest aircraft ever to fly. She made ten successful round trans-Atlantic trips to the United States in 1936, but burst into flames as she came in to land at Lakehurst, New Jersey at the end of her first flight of 1937 to the US.

Hugo Eckener

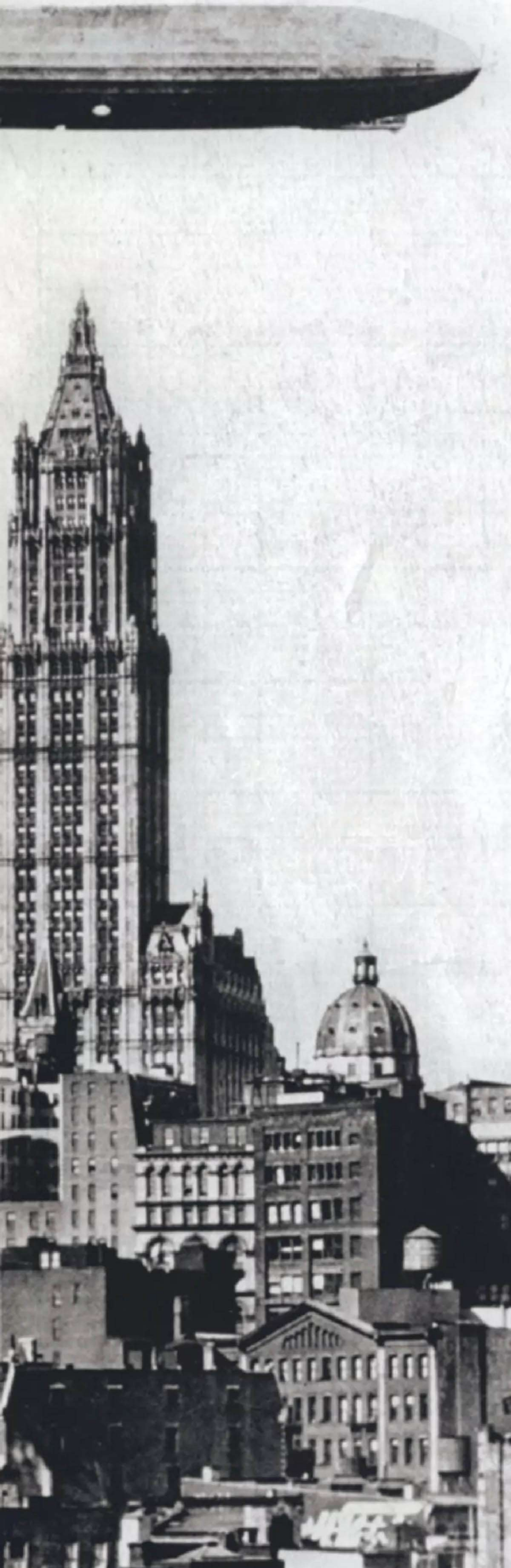
(1868–1954)

Hugo Eckener joined Zeppelin in 1906 as a publicist, but due to his natural aptitude for flying, he soon became an airship captain and during the First World War trained many Zeppelin pilots. After the war, as the head of Luftschiffbau Zeppelin, Eckener was instrumental in raising public support for airships and personally commanded the Graf Zeppelin on most of its record-setting journeys, including the first round-the-world passenger-carrying flight in the summer of 1929. Eckener always made safety his top priority and under him Zeppelin enjoyed a perfect operational record. This ended with the Hindenburg disaster of 1937 but by then Eckener, an ardent anti-Nazi, had been sidelined by Hitler's regime.



ABOVE: LZ 129 Hindenburg engulfed in flames on its arrival at Lakenhurst, New Jersey on 6 May 1937. The exact cause of the tragedy has never been fully established.

LEFT: Zeppelin LZ 127 Graf Zeppelin over New York in August 1934. The Zeppelins could cross the Atlantic in approximately two days. Their passengers travelled in very comfortable accommodation including private cabins, lounges, dining rooms and observation decks.



Miraculously, 62 of the 97 people on board survived the inferno but the disaster spelt the end of international airship travel.

As a result, flying boats remained the only aircraft suitable for long-range passenger transport over the world's oceans. As they could take off from and land on water, there was no need for long runways or complex airfields, both of which were difficult and expensive to construct, particularly in remote locations.

In the 1930s, Pan American or "Pan Am" became the preferred overseas airline of the US government. Under the dynamic direction of Juan Trippe, Pan Am set up routes in the early 1930s from the USA to the Caribbean and South America. Trippe then turned his attention to establishing routes across the Pacific. In October 1936, Pan Am's Martin 130 Philippine Clipper set off from California for the first scheduled trans-Pacific passenger flight. With scheduled stops on the way, the flying boat arrived in Hong Kong three days later.

In Europe, the French Latécoère operated flying boats over the Mediterranean and on South Atlantic mail flights. Lufthansa also introduced a Europe to South America mail service in 1934 using Dornier Wals, which stopped at a ship stationed in mid-ocean to re-fuel. Britain had used a mixture of flying boats, land-planes and trains on its routes to

Boeing 314 Clipper

With a 5,600-kilometres (3,500-mile) range, the Boeing 314 made its first transatlantic scheduled passenger flight in June 1939. The 314 was probably the most luxurious airliner ever built and was, for over 30 years, the largest commercial aircraft. It was capable of carrying 74 passengers seated or 40 in sleeping berths. Accommodation included a dining saloon that could be transformed into a lounge, plus a deluxe compartment that was offered as a bridal suite. Twelve of these aircraft were built between 1938 and 1941. They were drafted into wartime use and among the VIPs they carried were US President Franklin D Roosevelt and British Prime Minister Winston Churchill.

PAN AMERICAN AIR

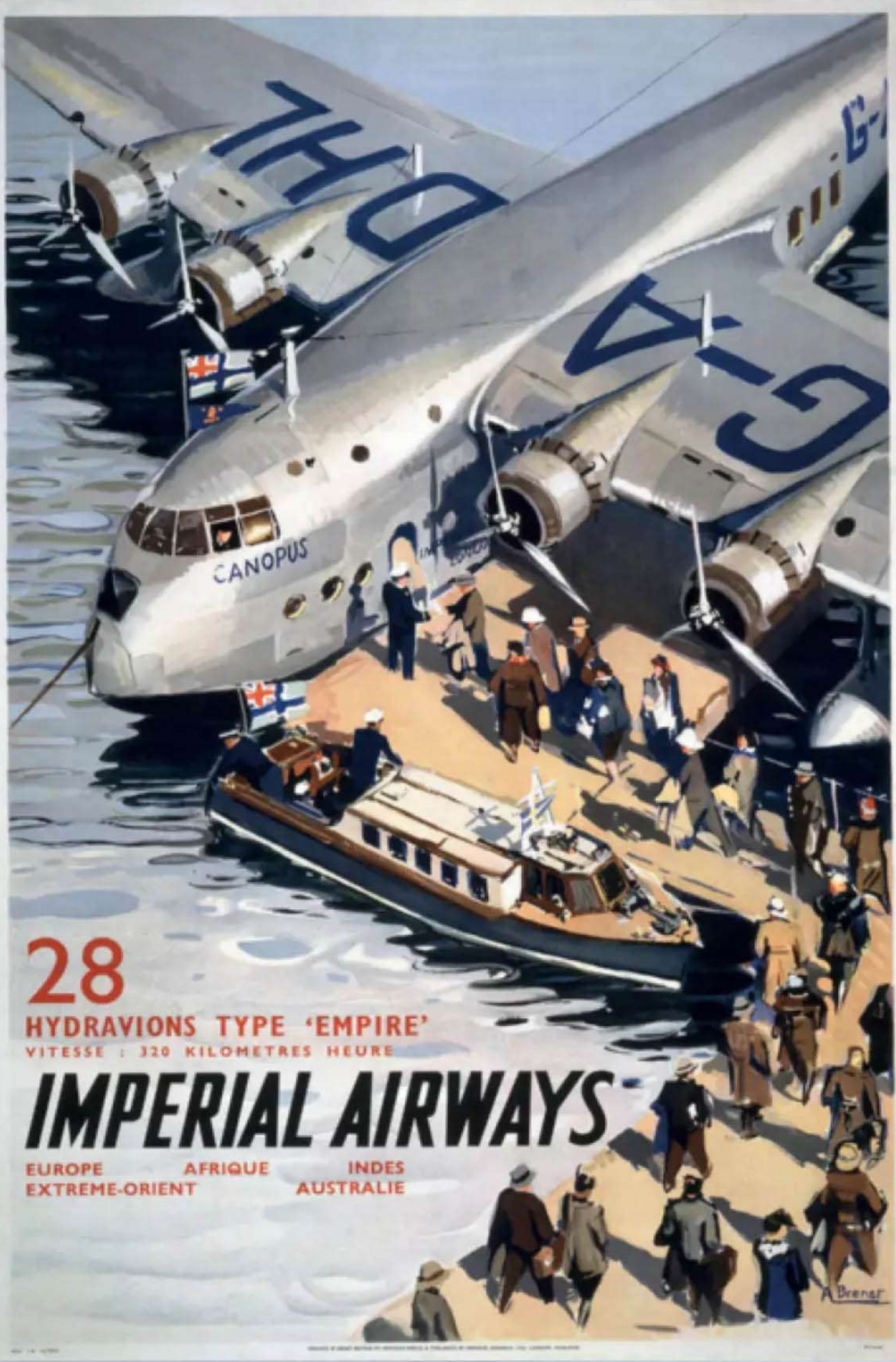
South Africa and Australia for a number of years but in 1937, Imperial Airways introduced the Short S-23 C-Class or Empire flying boats which flew in stages from Southampton to Cape Town and Sydney.

Pan Am's Clippers and Imperial's Empire flying boats were noted both for their high standards of passenger service and for their well-appointed accommodation. In May 1939, Juan Trippe introduced the most luxurious of all the flying boats, the Boeing 314, on to northern transatlantic routes, but the outbreak of the Second World War in Europe put an end to Pan Am's fledgling service. Although they continued to be used during the war, the construction of numerous airfields throughout the world, together with the development of land-planes with far longer flying ranges, effectively brought the flying boat era to an end.

LEFT: Passengers boarding a Pan Am Boeing Clipper flying boat.

BELOW: An Imperial Airways poster featuring an "Empire" or Short S-23 C-class flying boat. Canopus, the first C-Class, made its initial flights in 1936.

RWAYS SYSTEM


G-ADHL
CANOPUS
28
HYDRAVIONS TYPE 'EMPIRE'
VITESSE : 320 KILOMETRES HEURE
IMPERIAL AIRWAYS
EUROPE AFRIQUE INDES
EXTREME-ORIENT AUSTRALIE

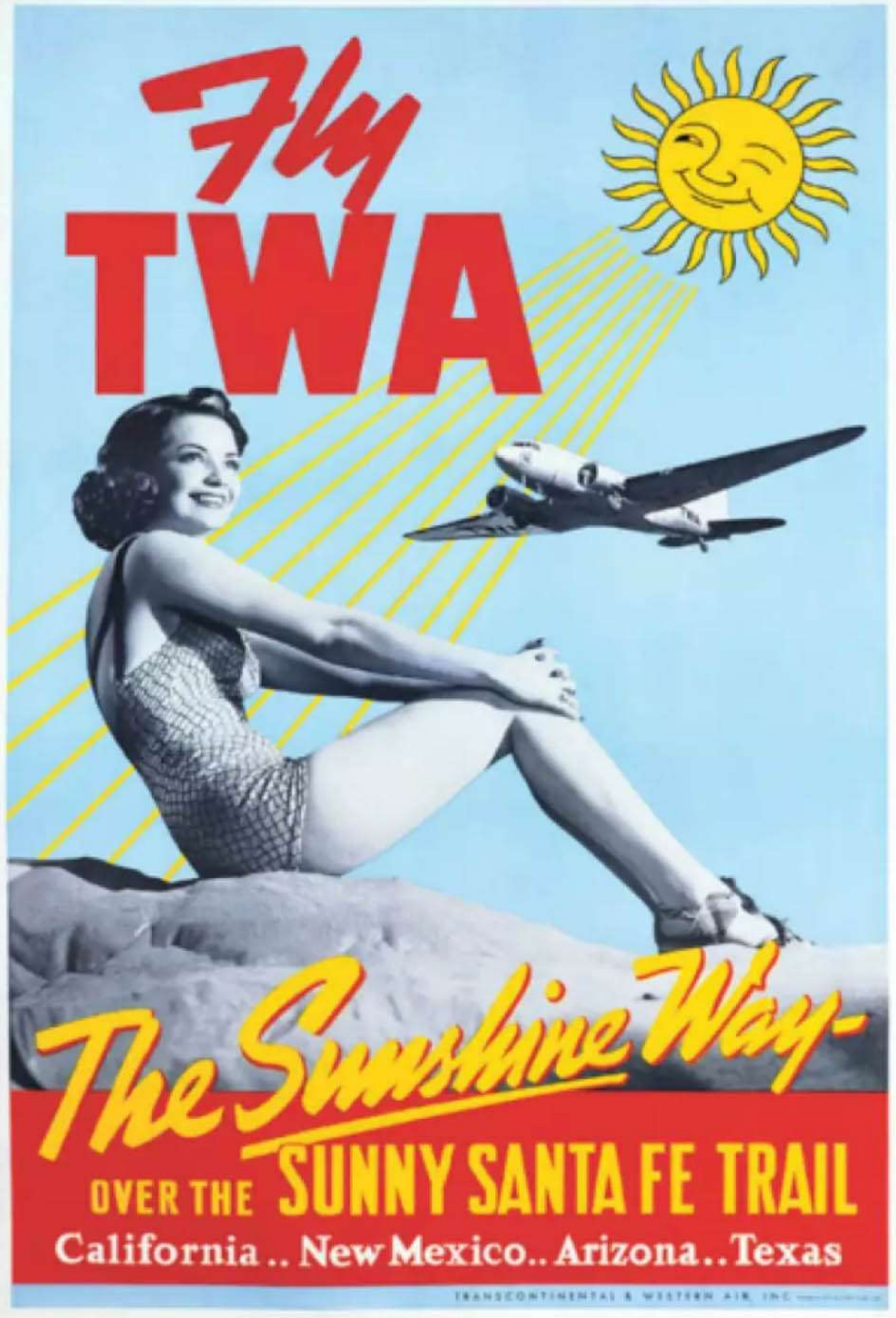
THE FIRST MODERN AIRLINERS

In 1918, the US Army Air Service initiated the world's first regular airmail service between Washington and New York. During the following year, the US Post Office took over and built a transcontinental service using its own pilots and aircraft and by 1924, had a continent-wide system of lights to guide aircraft at night. As a result, the mail could be flown across the US in 30 hours, compared to the three days it took by train.

This network was subsequently handed over to commercial operators and many small companies, such as the Robertson Aircraft Corporation, for whom Charles Lindbergh flew, started to carry mail. Lindbergh rose to fame in 1927 when he made the first solo flight across the Atlantic, an achievement that gave a tremendous boost to aviation, particularly in the US. New airlines rapidly developed. Soon carrying passengers as well as mail was a commonplace thing. By 1930, the "Big Four" – American Airlines, United Air Lines, Eastern Airlines and Transcontinental and Western Air, dominated almost all US domestic routes.

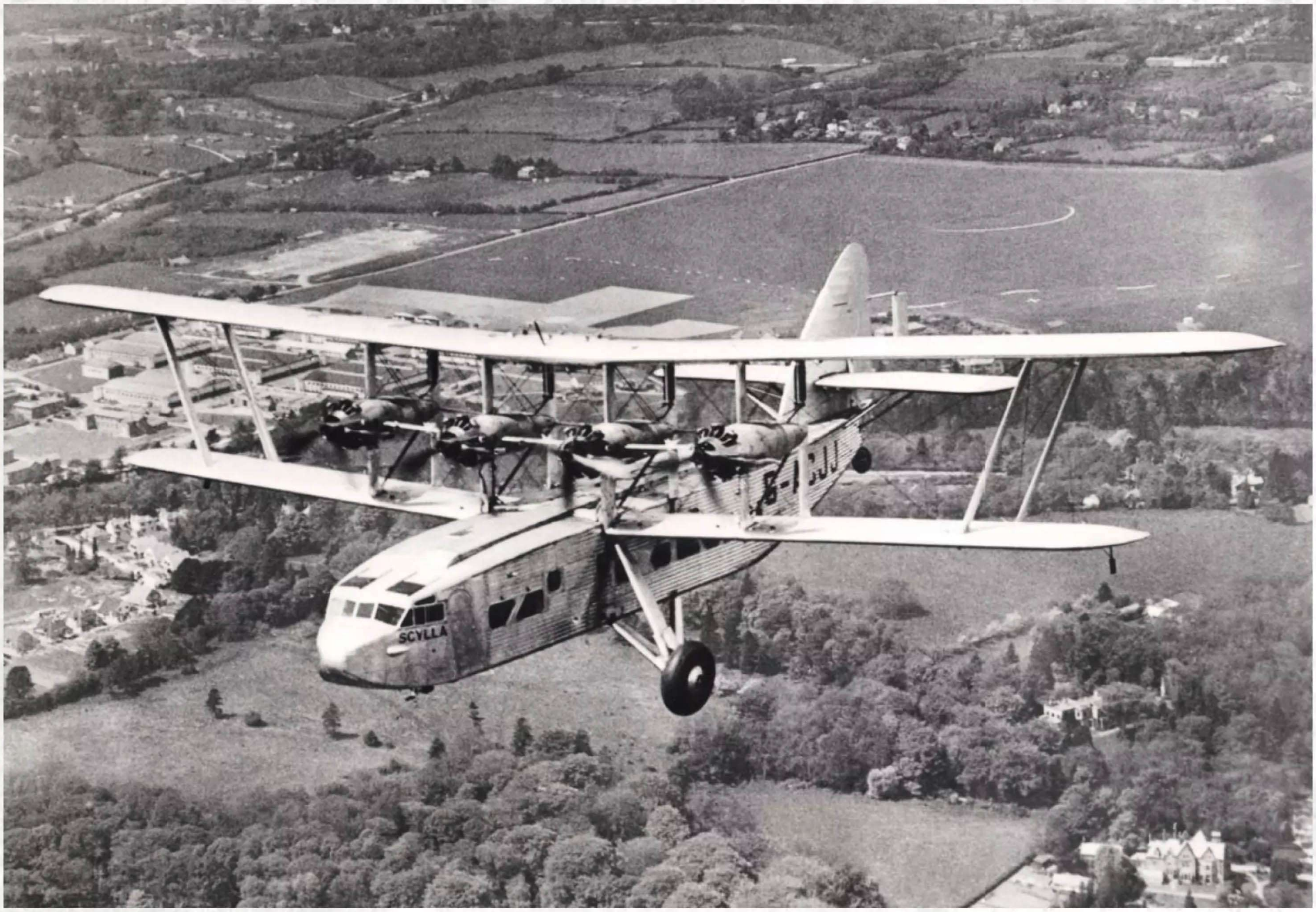
At the heart of this change were a number of new aircraft; the tough Ford, Fokker and Boeing trimotors with their three engines, one on each wing and another on the nose. These aircraft may have been fast, but they were also uncomfortable. But an even greater revolution was on the horizon with the advent of a new generation of sleek, aerodynamic all-metal monoplane airliners powered by increasingly efficient air-cooled radial engines. United Airlines led the way in 1933 with the introduction of the 250-kilometre-per-hour (155-mile-per-hour) Boeing 247 which could carry ten passengers in reasonable comfort in its soundproofed cabin. The 247 was so advanced that United's rivals were forced to replace their existing fleets and they turned to the Douglas Aircraft Company, who devised the DC series of aircraft. The DC-1 of 1933 was quickly followed by the DC-2. Superior to the 247, this was superseded in turn by the 290-kilometre-per-hour (180-mile-per-hour), 21-seat DC-3 in 1936. With the introduction of the DC-3 and improvements in radio, radio-based navigation and flying with instruments in poor visibility, US airlines were finally able offer a reliable service that could make money just from transporting passengers. Reduced fares encouraged more people to fly and by the late 1930s the DC-3 was carrying over 90 per cent of the three million or so American passengers travelling by air each year.

BELOW LEFT: TWA was one of the first US airlines to purchase the Douglas DC-3. TWA passengers travelled both on business and to vacation destinations.


Fly
TWA
The Sunshine Way
OVER THE SUNNY SANTA FE TRAIL
California.. New Mexico.. Arizona.. Texas
TRANSCONTINENTAL & WESTERN AIR, INC.

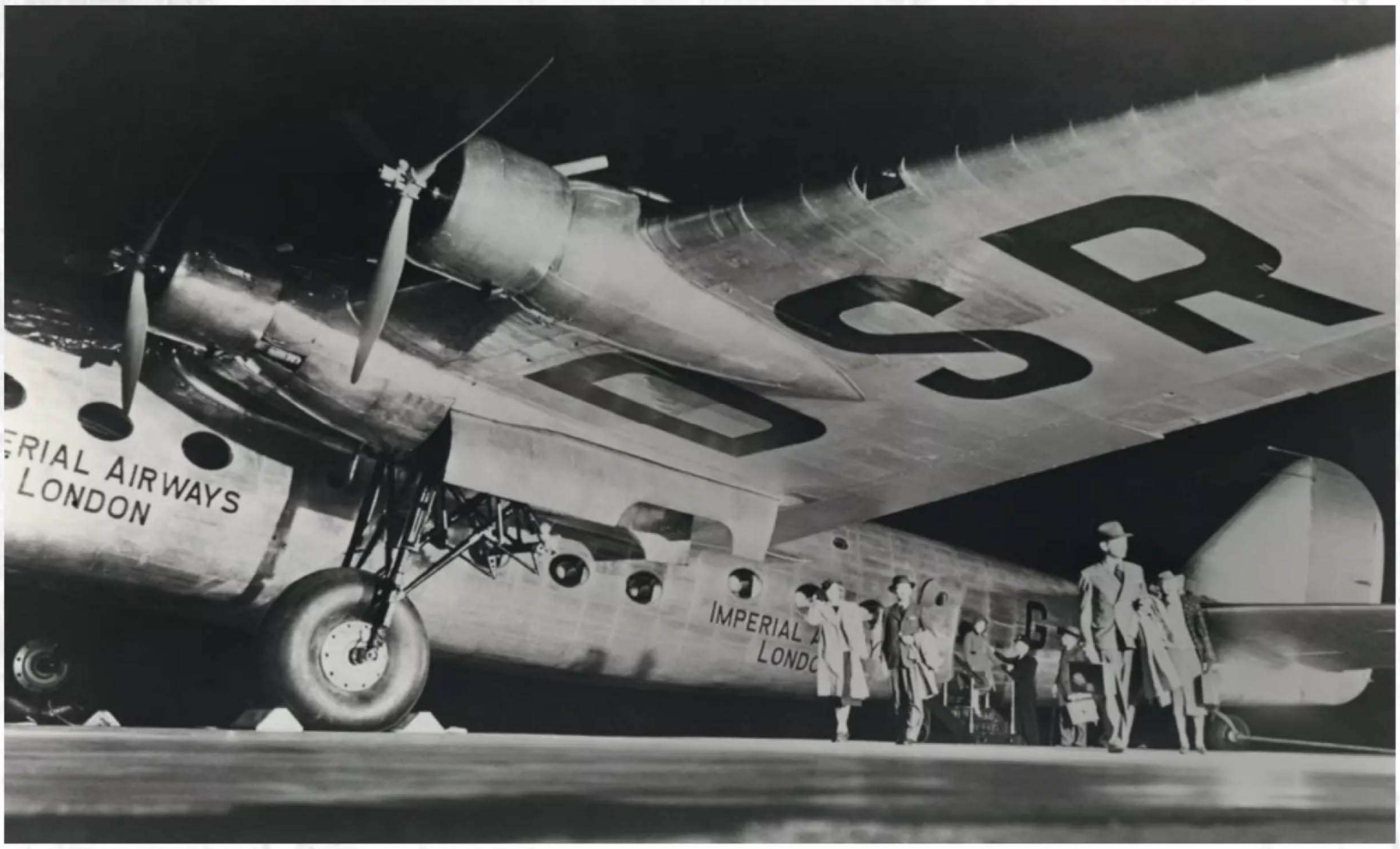
Howard Hughes
(1905–1976)

A wealthy industrialist, aviator, film director, producer and philanthropist, Howard Hughes learnt to fly in 1927 and founded the Hughes Aircraft Company in 1934 to make the H-1 racer in which he set a world land-plane speed record of 566.9 kilometres per hour (352.32 miles per hour) in 1935. In 1938 he set another record by flying around the world in a Lockheed 14 Super Electra in just over 91 hours, and in 1941 he took control of Transcontinental and Western Air, later known as Trans World Airlines (TWA), one of the famous "Big Four" airlines. 1947 saw the one and only flight of his famous wartime H-4 Hercules transport aircraft Spruce Goose. Suffering from worsening obsessive-compulsive disorder and increasingly surrounded by controversy, Hughes died an eccentric recluse in 1976.



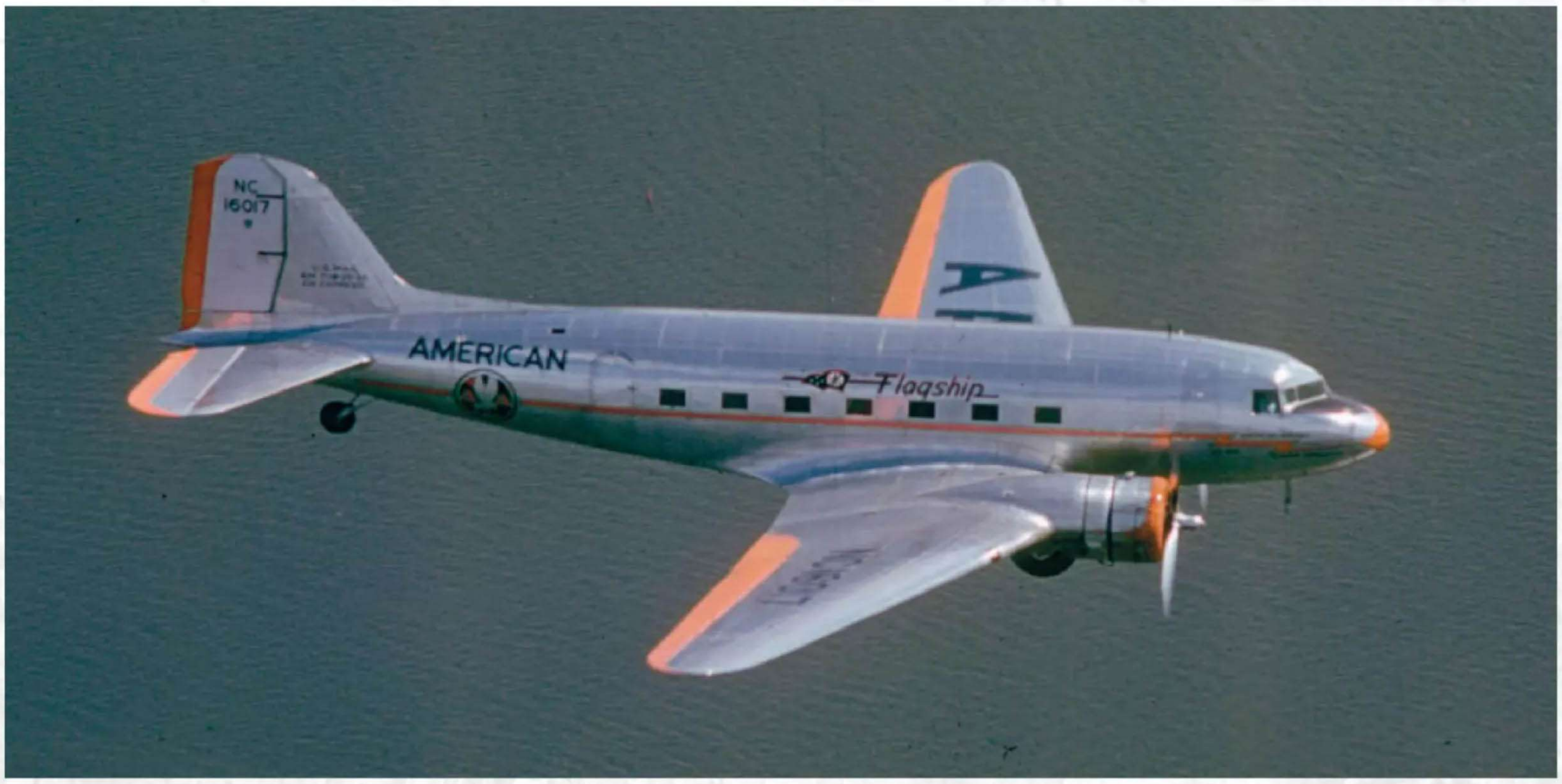
ABOVE: An Imperial Airways Handley Page HP42. These large biplanes carried 24 passengers on Empire and European routes from 1930 until almost the end of the decade. Travelling at a steady 161 kilometres per hour (100 miles per hour) they quickly gained a reputation for both safety and reliability.

RIGHT: Passengers leave an Imperial Airways Armstrong Whitworth AW Ensign. Although modern in appearance and equipped with a spacious cabin, the Ensign didn't measure up to the designs of its contemporary American rivals.



An American Airlines DC-3 parked
on the tarmac at La Guardia airport,
New York City in the 1940s.

AMERICAN AIRLINES
GSHIP NEWAR


NC
16017
AMERICAN
Flagship

LEFT: An American Airlines Douglas DC-3 in flight.

Douglas DC-3

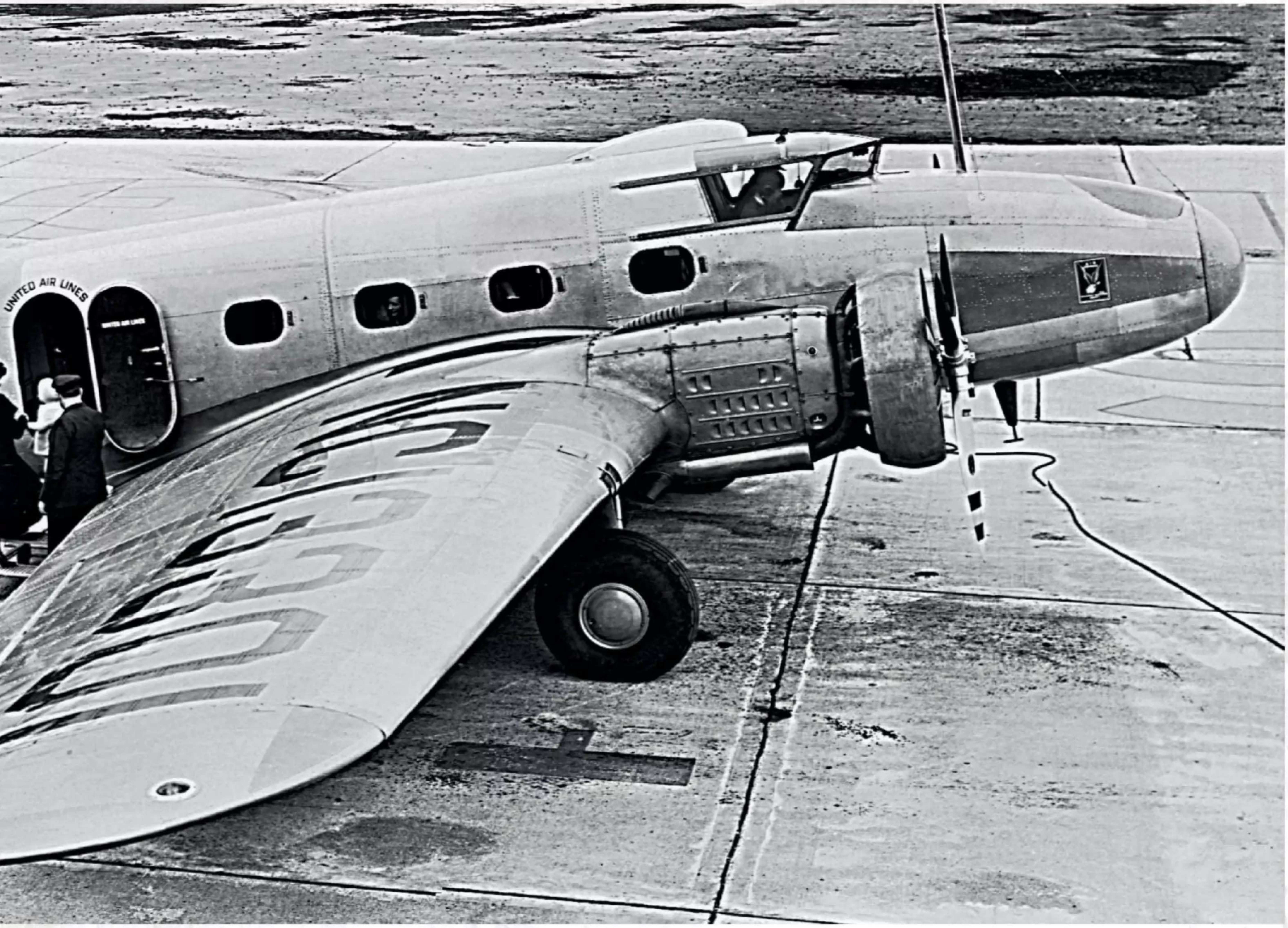
The Douglas DC-3 was the most successful aircraft of its day and indeed, many would argue that it is the greatest of all time. Design work on the DC-3 began in 1934 at the request of American Airlines who wanted a longer DC-2 to carry more passengers, plus another version with sleeping berths. The 14-berth Douglas Skysleeper was soon eclipsed by the standard 21-seat DC-3 which was both comfortable and very reliable. It could operate from concrete, grass and even dirt surfaces and its crews considered it to be virtually indestructible. In addition to the 455 DC-3s made, 10,174 of the C-47 military version were also produced, some of which are still flying today.

NC
13301
BOEING
UNITED
PACIFIC
BOEING
AIR TRANSPORT
AIR LINES

In contrast to the DC-3, European designs lagged far behind. The Handley Page HP42 introduced by Imperial Airways in 1930 was a giant biplane which carried 24 passengers at a stately 161 kilometres per hour (100 miles per hour) on the airline's Empire and European routes. Newer designs followed, such as the all-metal stressed skin Armstrong Whitworth AW27 Ensign and de Havilland's beautiful DH 91 Albatross, which entered service just before the outbreak of the Second World War. By the late 1930s, US air passengers could travel in properly heated, soundproofed comfort, attended by stewardesses or stewards, serving in-flight drinks and meals, with beds even being provided on some of the more lavish services.

However, the problem of turbulence created by adverse weather conditions remained a prominent issue. The solution was to fly higher into the realms of the weather-free stratosphere. Boeing's B-307 Stratoliner of 1938 was the first airliner capable of doing this. With its pressurized cabin and turbo supercharged engines which could work efficiently at such increased heights, it indicated the direction that commercial aviation was to take.

BELOW: Passengers boarding a Boeing 247 at Boeing Field in Seattle. With its streamlined all-metal, cantilevered wing design and retractable undercarriage, the Boeing 247 was the first true modern airliner, but it was soon to be upstaged by Douglas's DC-2 and DC-3.



THE APPROACH AND OUTBREAK OF THE SECOND WORLD WAR

Whilst the development of passenger flight continued, the military value of aircraft had not been forgotten, but there was by no means consensus on how best they should be employed. In Britain, a role was found for the RAF in "policing the Empire" (keeping the peace in the colonies). In France, the perennial fear of German militarism provided justification for maintaining an air force, and in Italy the rise of Mussolini prompted the expansion of that country's air arm to support its own imperial plans. In the United States, the focus was on defence, while Japan began to build a carrier fleet. But it was to be Germany whose air force (the Luftwaffe) would shape the development of air power in the 1930s, leading other nations to re-arm as Hitler's territorial ambitions became increasingly apparent.

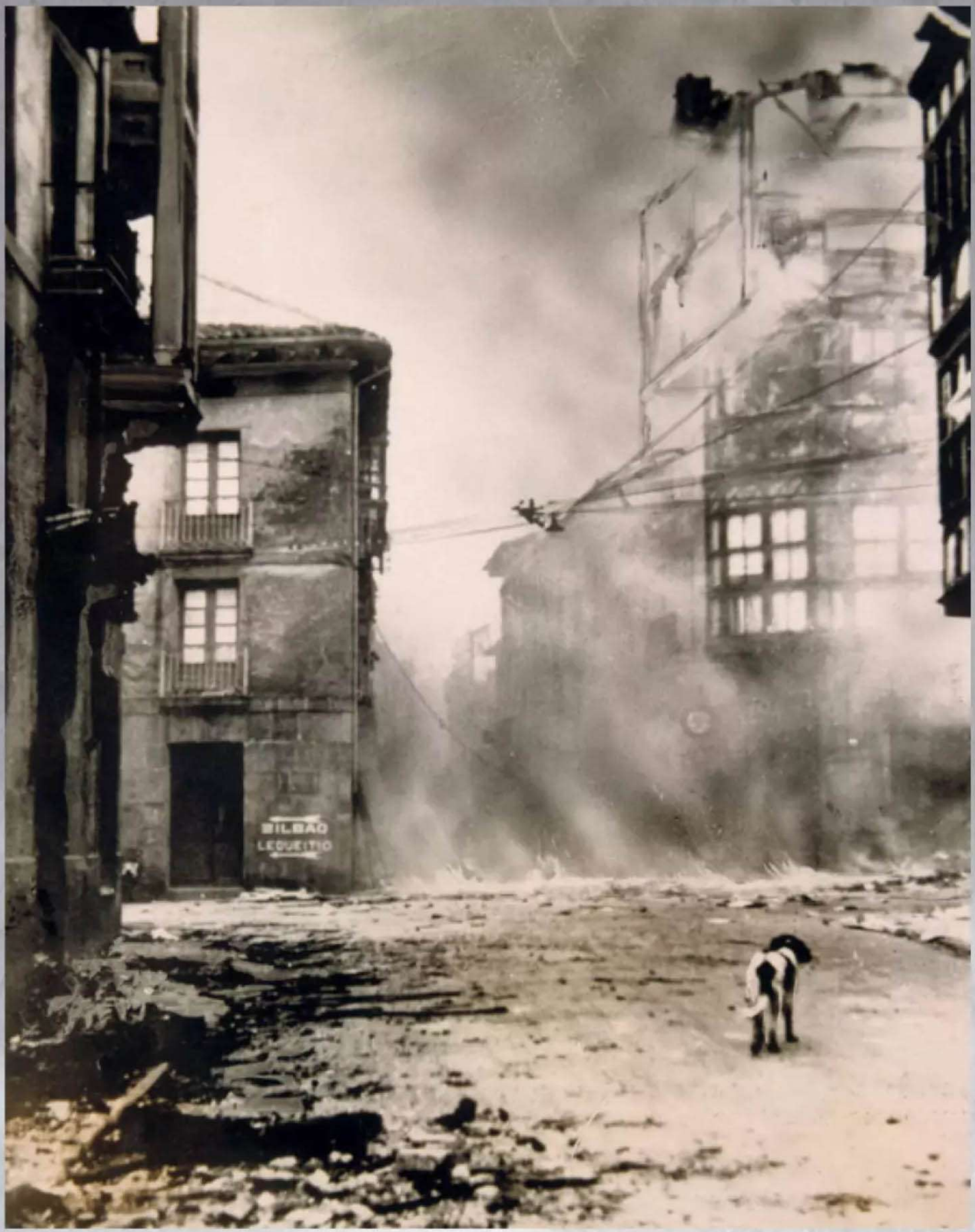
Germany was forbidden by the terms of the Treaty of Versailles from having an air force. However, in the 1920s, an agreement with the Soviet Union meant that it secretly continued to train military pilots there. Aircraft development continued too, often under the guise of building for commercial aviation. In 1933, when Hitler and the Nazis took power, Germany began to re-arm more swiftly, soon unveiling its air force, the Luftwaffe, to the world. More pilots commenced training and the German aircraft industry began to produce new combat aircraft which were at the cutting edge of modern design. By the mid-1930s, biplane aircraft were being replaced by monoplanes such as the Messerschmitt Bf 109 fighter.

The Luftwaffe proved the effectiveness of its aircraft, tactics and personnel during the Spanish Civil War (1936–1939), when the Condor Legion was despatched to Spain to fight on the Nationalist (Fascist) side. The Bf 109 outfought the Republican Soviet-designed fighters, and the Legion began to carry out close air-support operations, working with the army on the ground to

Erhard Milch

1892–1972

Milch did more than any other individual to shape the development of the Luftwaffe. He was born in Wilhelmshaven, served as a fighter pilot in the First World War and joined the German national airline, Lufthansa, in 1926. An early supporter of the Nazi party, Milch was Hermann Göring's deputy at the air ministry and he organized the construction of the Luftwaffe at a time when Germany was forbidden to have an air force. He commanded forces during the invasion of Norway in 1940, and was instrumental in increasing aircraft production from late 1941 onwards. He was sentenced to life imprisonment at the Nuremberg Trials in 1947, but this was later commuted to 15 years.



RIGHT: Guernica, Spain, after it had been attacked by the Luftwaffe in 1937. Guernica came to symbolize the horror of aerial attack on civilians and also inspired one of the most powerful works of art to emerge from war – Pablo Picasso's painting of the same name.

BELOW: Adolf Hitler and a group of his senior commanders watch a flypast of German aircraft in 1935. The Luftwaffe was a vital part of German battle strategy.

destroy enemy troop concentrations and communications. A valuable lesson was learned in the use of aircraft as "aerial artillery", although it was the attack by German aircraft on Guernica in April 1937 that came to symbolize the German involvement in the war, and seemed to prove the awesome destructive power of the bomber against civilian targets.

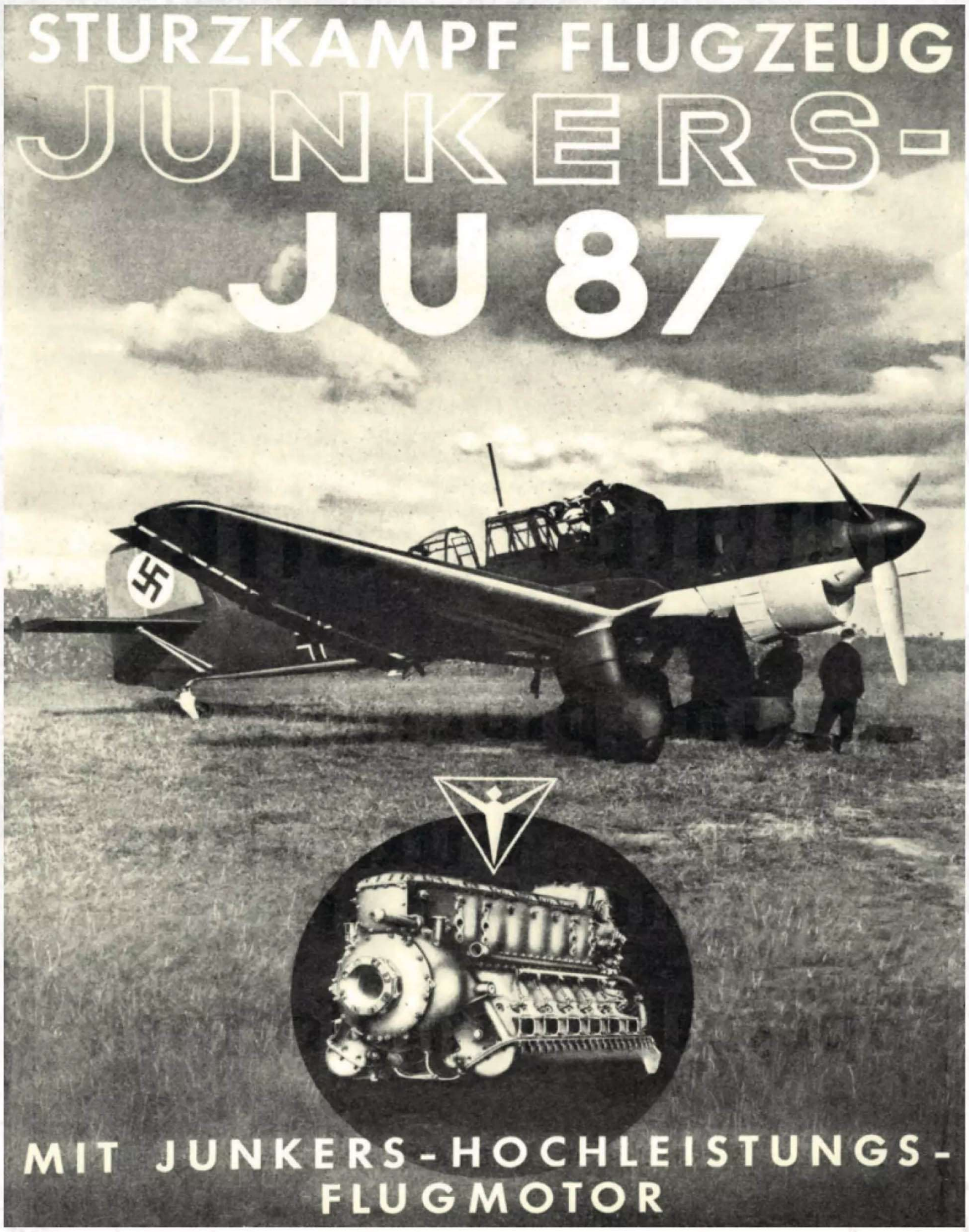
When Germany invaded and conquered Poland in September 1939, it heralded to the world that a new form of warfare had arrived. Blitzkrieg, or "Lightning War", involved tanks and mechanized infantry advancing at breathtaking speed through enemy defences that had been smashed by the aerial artillery – specifically Ju 87 Stuka dive bombers. This type of combat did not rely on huge numbers of aircraft or highly advanced technology. Concentration of force and speed of action were key, as was achieving air superiority over the battlefield.

When the Germans invaded France, the British and French commanders also found themselves outmanoeuvred, just like the Polish military. Firstly airfields were attacked, crippling the Allies' ability to maintain air superiority. Although fighters such as the Hawker Hurricane were able to match the German aircraft in terms of performance, others such as the Morane-Saulnier MS 406 were not up to the job. As the German army advanced westwards, with the Luftwaffe spearheading the attack, allied squadrons were forced to retreat. The aircraft with which the RAF counter-attacked, such as the Bristol Blenheim and Fairey Battle light bomber, achieved little. Many were destroyed, and pre-war trained airmen lost.

By the summer of 1940, Germany was in control of continental Europe from Poland through to the English Channel, partly because of the innovative use of air power. Only the miraculous evacuation of the British Expeditionary Force and remnants of the French army at Dunkirk prevented the German victory from being overwhelming and absolute.

Junkers Ju 87 Stuka

No aircraft is more associated with Blitzkrieg than the Ju 87 Stuka. The "lightning war" strategy centred on tanks and mechanized infantry receiving close support by "aerial artillery"– in particular, the Ju 87. The Stuka (the name was derived from Sturzkampfflugzeug, meaning dive-bomber) entered service in 1937. A notable modification to the aircraft was the addition of sirens to the landing gears, which caused the Stuka to emit a distinctive wail as it dived. Despite its devastating early performance, its slow speed made it vulnerable to fighter attack. After the Battle of Britain in 1940, when large numbers of Ju 87s were shot down, their effectiveness markedly decreased, and although they continued in service, they never again enjoyed the same level of success.



OPPOSITE, ABOVE: The German invasion of Poland, September 1, 1939. A key component of Blitzkrieg was the aerial artillery provided by the Luftwaffe. 890 bombers were deployed by the German air force in the campaign and Poland was overwhelmed within a month by rapidly moving ground forces supported by aircraft.

OPPOSITE, BELOW: Shanghai being bombed by Japanese aircraft. In the 1930s Japan used its aircraft as a way to attack the morale of Chinese civilians. The bombing of Shanghai in 1932 was one of the first uses of carrier-based bombers in the Pacific.

RIGHT: A German poster promoting the Junkers Ju 87 Stuka, one of the Luftwaffe's most formidable weapons during the early years of the Second World War.

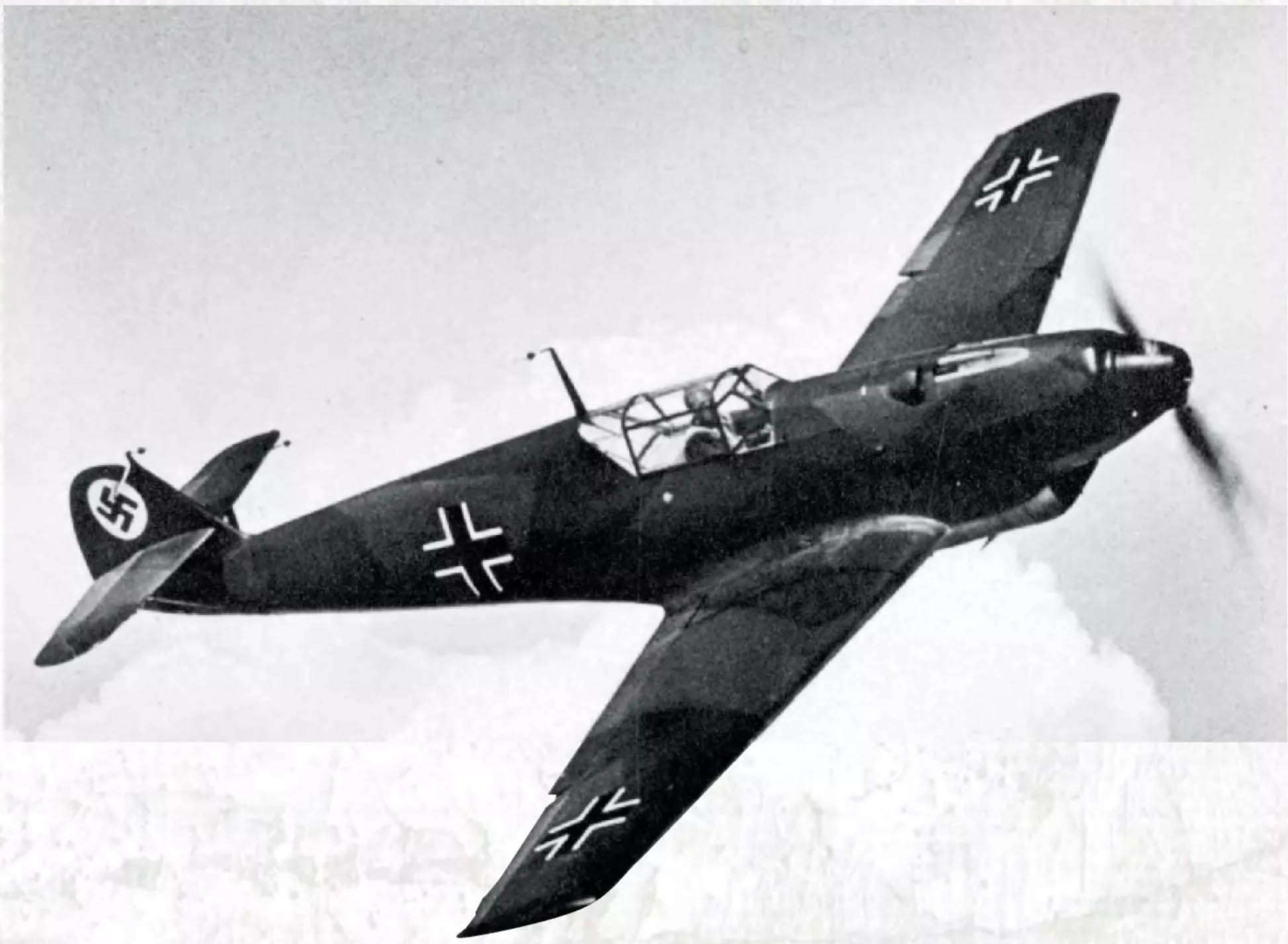
THE BATTLE OF BRITAIN AND THE BLITZ

"What General Weygand called the Battle of France is over. I expect that the Battle of Britain is about to begin." With those words, British Prime Minister Winston Churchill announced that the United Kingdom could expect the full force of the Nazi war machine, which had swept largely unchecked across Europe, to be directed across the English Channel. Hitler ordered his air force to achieve air superiority over the United Kingdom as a necessary prelude to invasion.

Defending the British Isles from the threat of the bomber became a high priority for military planners. An intricate early-warning system was in place, based on the principles of defence established during the First World War. Well organized command and control was augmented by the latest scientific miracle – radar – assisted by the more traditional teams of observers on the ground ready to report incoming aircraft. The RAF did not have as many aircraft or pilots as the Luftwaffe but it had a simple task: to remain in being. Unless the Germans could destroy the United Kingdom's ability to defend itself from the air, the invasion could not take place.

The battle for aerial supremacy, which became known as the Battle of Britain, began in June 1940 with sporadic attacks by the Luftwaffe over the Channel. These intensified in July. Then, on 13 August, massive fleets of German bombers and their escorting fighters attacked the bases, radar installations and centres of aircraft production that were vital to the defences. The pilots of the RAF came

ABOVE RIGHT: Pilots of No. 610 Squadron Royal Air Force between sorties at RAF Hawkinge, Kent, 1940. Squadrons were held at different states of readiness, ranging from "available" (ready to take off in 20 minutes) to "stand-by" (two minutes). Once the call to "scramble" was given, the pilots would run to their aircraft, knowing that every second gained could give them more time to climb to a good altitude for attack. During the heaviest days of fighting, squadrons could be called into action several times, pausing only to re-arm and refuel.



BELOW RIGHT: The Messerschmitt Bf 109. Designed by engineer Willy Messerschmitt, over 30,000 109s of various different marks were built. The 109, one of the first all-metal monoplanes to enter service, was small, light, fast and manoeuvrable. The small cockpit did not give the pilot a good view, and it was difficult to handle at low speeds, but it proved to be a very capable fighter.

RIGHT: Hawker Hurricanes of No. 501 Squadron, Gravesend, 14 September 1940. Designed by Sydney Camm, the Hurricane was part of the first generation of monoplane fighters, and it entered service in 1937. Like the Spitfire, the Hurricane was fitted with the Rolls-Royce Merlin engine.

BELOW: Supermarine Spitfire Mk IAs of No. 610 Squadron. This variant of Spitfire was armed with eight Browning .303 inch machine guns. Later marks were fitted with cannons (firing explosive shells, rather than small rifle bullets) which after some early problems, proved much more effective. Key to the Spitfire's success was its innovative design and powerful, reliable Rolls-Royce Merlin engine.

St Paul's Cathedral stands above the surrounding burning buildings during the Blitz. Winston Churchill was aware of the powerful national symbolism provided by the survival of the iconic building, stating during the Blitz that "At all costs, St Paul's must be saved".

from the UK, the Commonwealth, occupied Europe and the United States, and they fought doggedly and determinedly to stem the tide. Luftwaffe attacks increasingly began to focus on the airfields, in an attempt to destroy the Allies' Spitfires and Hurricanes on the ground and deprive them of the bases from which the defence was maintained.

These attacks proved effective for the Luftwaffe but although the RAF was hard-pressed, it was able to hang on. Then in September, the Luftwaffe turned its attention to London. This provided respite for the RAF. By October, it was clear that the Luftwaffe would not achieve air superiority over Britain. It would instead concentrate on bombing British cities by night, in what became known as the "Blitz". The RAF had effectively ended the threat of invasion. It was, as Churchill had predicted, "their finest hour".

But the cities continued to suffer. The German attacks were the first real sustained attempt to test British Prime Minister Stanley's Baldwin's theory that "the bomber will always get through", and see whether civilian morale would crack under the pressure of aerial bombardment. Until May 1941, bombers such as the Heinkel He 111 and Junkers Ju 88 attempted to batter London into submission. They were guided by very sophisticated navigation systems, and had considerable success avoiding British anti-aircraft defences. 10 May saw the largest number of casualties, when over 1,400 civilians were killed. The Blitz meant that thousands of ordinary men and women had a role to play in defending the nation, in both military and civilian capacities. They worked as first aiders, air raid wardens and firefighters and manned anti-aircraft batteries and barrage balloon defences.

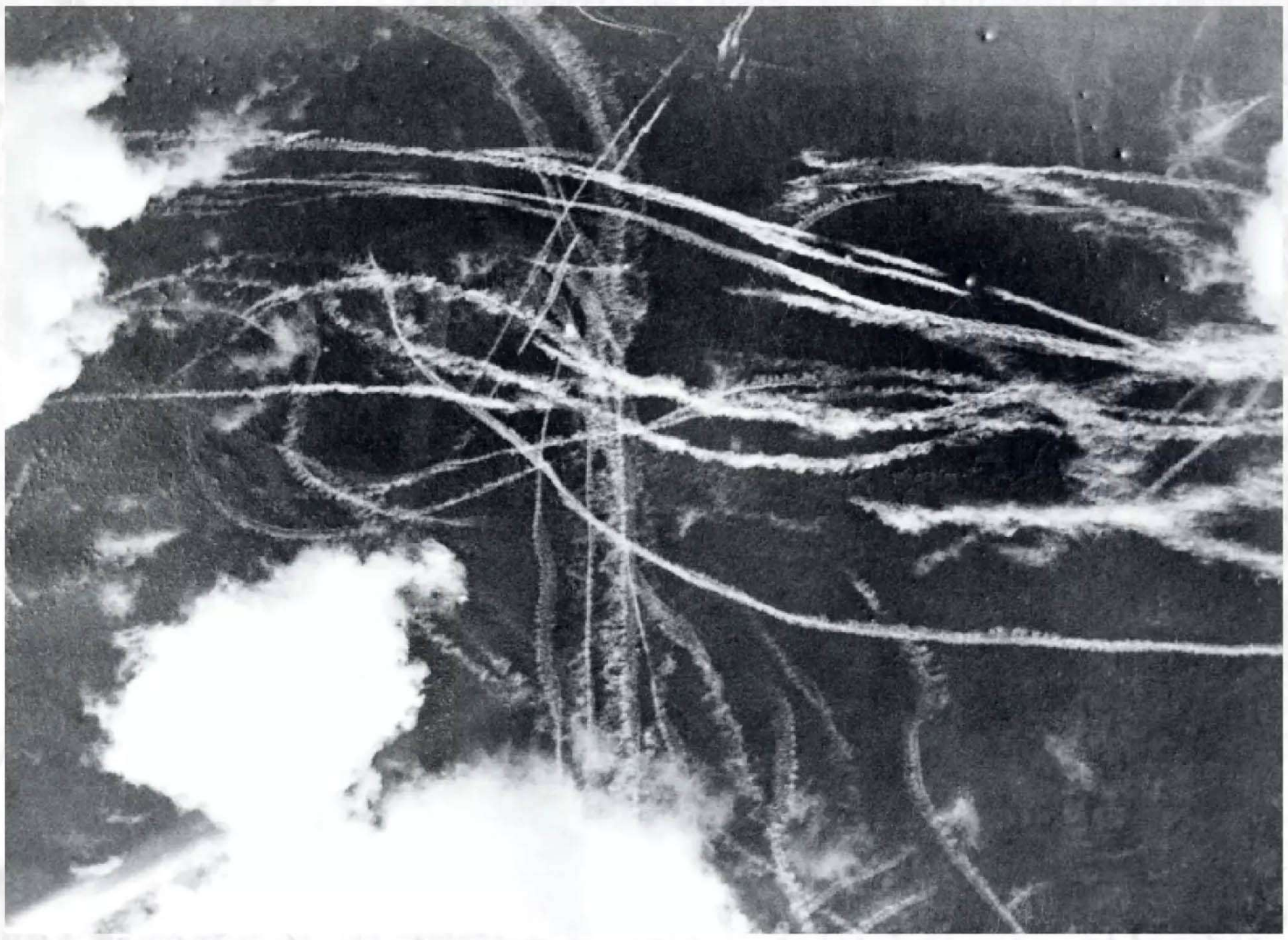
German attacks lessened as Hitler turned his attention to the Russian front, but raids on Britain continued sporadically. Then in 1944, a new weapon was introduced – the pilotless V1 flying bomb. In the summer of that year, around 100 V1s were sent across the Channel every day, proving difficult to intercept thanks to their size and speed. V1s were followed by the even more deadly V2 ballistic missiles, which were impossible to intercept. The RAF made enormous efforts to destroy these weapons at source, by bombing their launch sites and production centres.

The Blitz on London and other British cities was a horrendous demonstration of the power of the bomber. But at no point did it seriously threaten to destroy British morale. And the scale of the German effort would be dwarfed by what was to follow: the enormous Allied strategic bombing campaign.

Sir Hugh Dowding

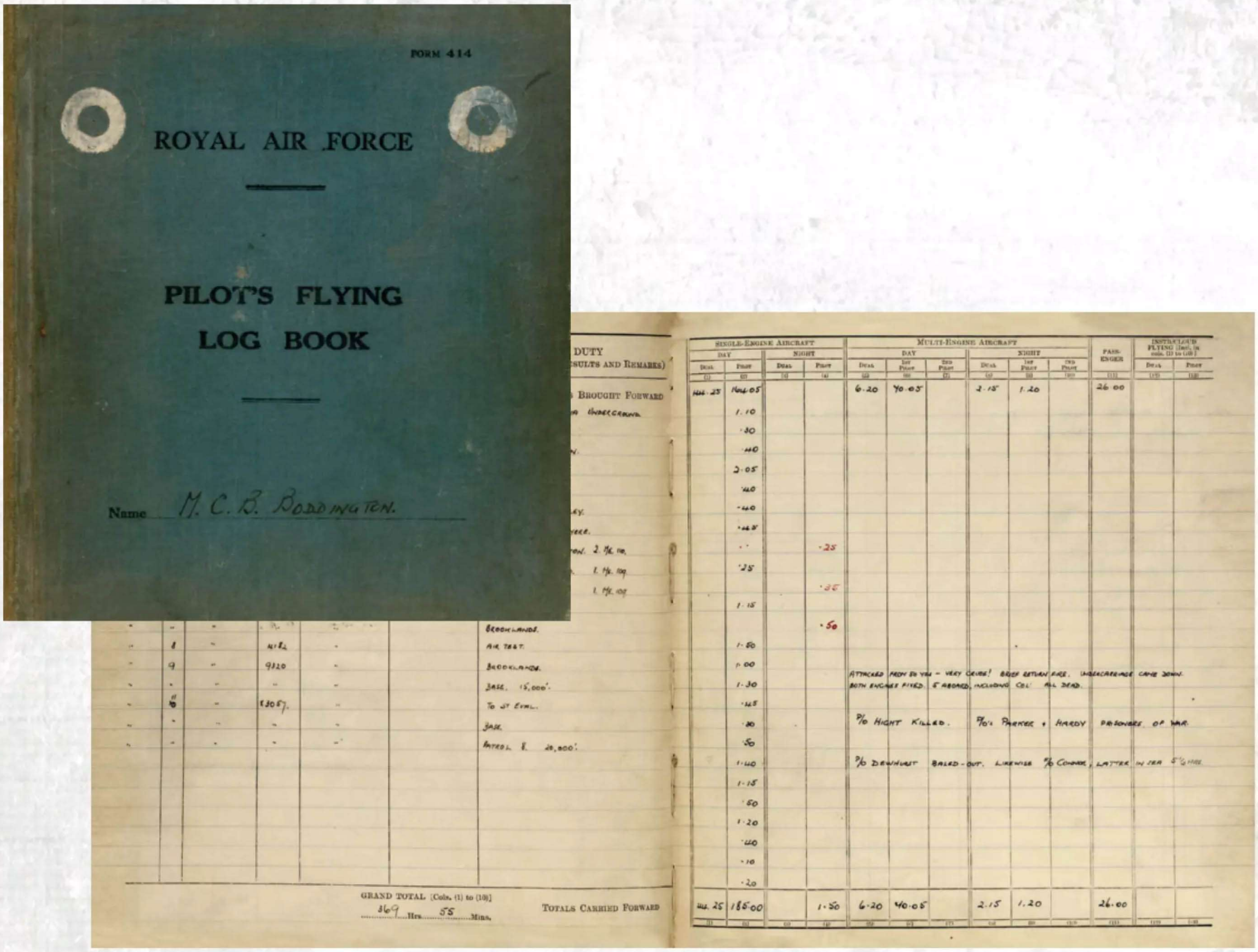
(1882–1970)

Dowding was made Commander-in-Chief of RAF Fighter Command in 1936. Until the outbreak of war, he worked tirelessly to prepare Britain's air defences against the attack that many felt was inevitable. These included the development of the "Chain Home" radar network, and the perfecting of the command and control systems that would prove so valuable during the Battle of Britain. Dowding refused to allow the dispersal of his Spitfire squadrons during the ill-fated Norwegian campaign and the Battle of France in 1940 and successfully managed the resources at his disposal during the Battle of Britain itself. To him must go a great deal of the credit for victory.



OPPOSITE: An extract from Pilot Officer Michael Christopher Bindloss Boddington's logbook, which covers the period 2 August–11 September 1940. Boddington, from Hawkshead, Lancashire, flew with No. 234 Squadron during the Battle of Britain. He joined the Royal Air Force Volunteer Reserve (RAFVR) in 1936 and after the Battle went on to command squadrons in North Africa, Malta and Sicily.

LEFT: The pattern of condensation trails left by British and German aircraft after a dog fight. Before the war the RAF's tactics were based on the idea that unescorted bombers would be the target for the defending fighters. Formations were rigidly organized, and it was thought unlikely that there would be much fighter-against-fighter combat. However, the pilots' experiences in the Battle of France and the early stages of the Battle of Britain forced tactics to change, leading to intense dogfighting as fighters manoeuvred desperately to bring their guns to bear.



FORM 414

ROYAL AIR FORCE

PILOT'S FLYING LOG BOOK

Name M. C. B. BODDINGTON.

DUTY (INCLUDING RESULTS AND REMARKS)

TOTALS BROUGHT FORWARD

"	"	"				BROOKLANDS.
"	8	"	N182	"		AIR TEST.
"	9	"	9320	"		BROOKLANDS.
"	"	"	"	"		BASE. 15,000'.
"	11	"	K3057.	"		TO ST EVAL.
"	"	"	"	"		BASE.
"	"	"	"	"		PATROL 8. 20,000'.

GRAND TOTAL [Cols. (1) to (10)] 369 Hrs. 55 Mins.

TOTALS CARRIED FORWARD

SINGLE-ENGINE AIRCRAFT — MULTI-ENGINE AIRCRAFT — PASSENGER — INSTR/CLOUD FLYING

44.25 | 144.05 | | | 6.20 | 40.05 | | 2.15 | 1.20 | | 26.00

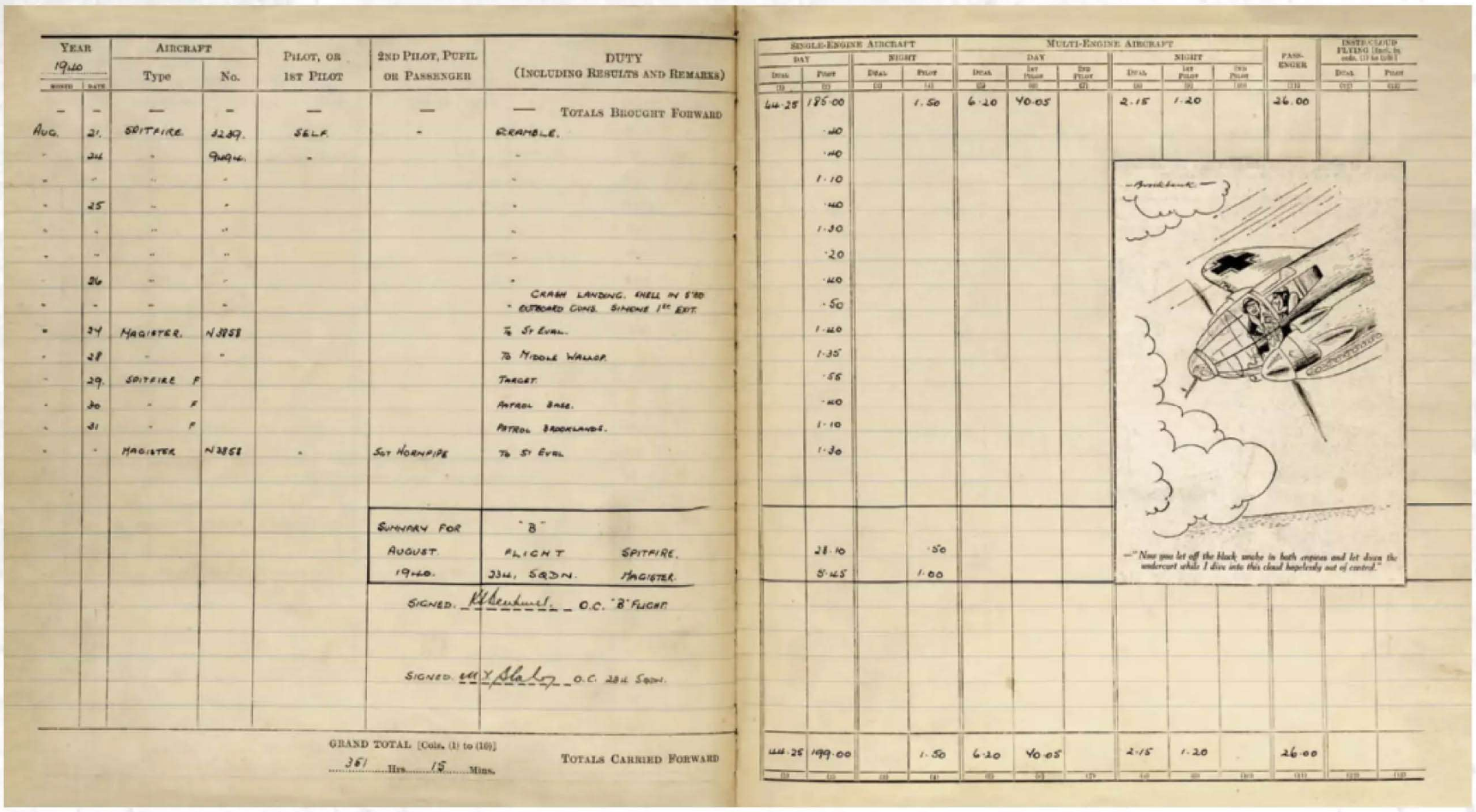
1.10, ·30, ·40, 2.05, ·40, ·40, ·45, ·25 (Night Pilot), ·25, ·35 (Night Pilot), 1.15, ·50 (Night Pilot), 1.50, 1.00, 1.30, ·45, ·30, ·50, 1.40, 1.15, ·50, 1.20, ·40, ·10, ·20

ATTACKED FROM BELOW – VERY CRUDE! BRIEF RETURN FIRE. UNDERCARRIAGE CAME DOWN. BOTH ENGINES FIRED. 5 ABOARD, INCLUDING COL' ALL DEAD.

P/O HIGHT KILLED. P/O's PARKER + HARDY PRISONERS OF WAR.

P/O DEWHURST BALED-OUT. LIKEWISE P/O CONNOR, LATTER IN SEA 5½ HRS.

44.25 | 185.00 | | 1.50 | 6.20 | 40.05 | | 2.15 | 1.20 | | 26.00



YEAR 1940 MONTH	DATE	AIRCRAFT Type	No.	PILOT, OR 1ST PILOT	2ND PILOT, PUPIL OR PASSENGER	DUTY (INCLUDING RESULTS AND REMARKS)
—	—	—	—	—	—	— TOTALS BROUGHT FORWARD
AUG.	21.	SPITFIRE	3289.	SELF.	-	SCRAMBLE.
"	24	"	9494.	"		"
"	"	"	"			"
"	25	"	"			"
"	"	"	"			"
"	"	"	"			"
"	26	"	"			"
"	"	"	"			CRASH LANDING. SHELL IN STBD " OUTBOARD CONS. SIMONE 1ST EXIT
"	27	MAGISTER.	N3858			TO ST EVAL.
"	28	"	"			TO MIDDLE WALLOP.
"	29.	SPITFIRE F				TARGET.
"	30	" F				PATROL BASE.
"	31	" F				PATROL BROOKLANDS.
"	"	MAGISTER	N3858	"	SGT HORNPIPE	TO ST EVAL

SUMMARY FOR AUGUST. 1940. — "B" FLIGHT 234, SQDN. — SPITFIRE. 28.10 / ·50 — MAGISTER 5.45 / 1.00

SIGNED. R.H. Dewhurst O.C. "B" FLIGHT.

SIGNED. M.V. Blake O.C. 234 SQDN.

GRAND TOTAL [Cols. (1) to (10)] 361 Hrs. 15 Mins.

TOTALS CARRIED FORWARD

44.25 | 185.00 | | 1.50 | 6.20 | 40.05 | | 2.15 | 1.20 | | 26.00

·40, ·40, 1.10, ·40, 1.30, ·20, ·40, ·50, 1.40, 1.35, ·55, ·40, 1.10, 1.30

—"Now you let off the black smoke in both engines and let down the undercart while I dive into this cloud hopelessly out of control."

44.25 | 199.00 | | 1.50 | 6.20 | 40.05 | | 2.15 | 1.20 | | 26.00

THE BOMBER WAR

After the Battle of Britain and the Blitz were over, bombing offered the United Kingdom a way to strike back at Germany at a time when grappling with the Nazi war machine on the ground was not an option. Some military commanders took this further, arguing that not only were bombers irresistible, they packed such a deadly punch that they could win a war on their own. Initially, however, despite the best efforts of the crews, a lack of suitable aircraft, poor navigational and bomb-aiming equipment and inadequate training meant that the first raids were very inaccurate.

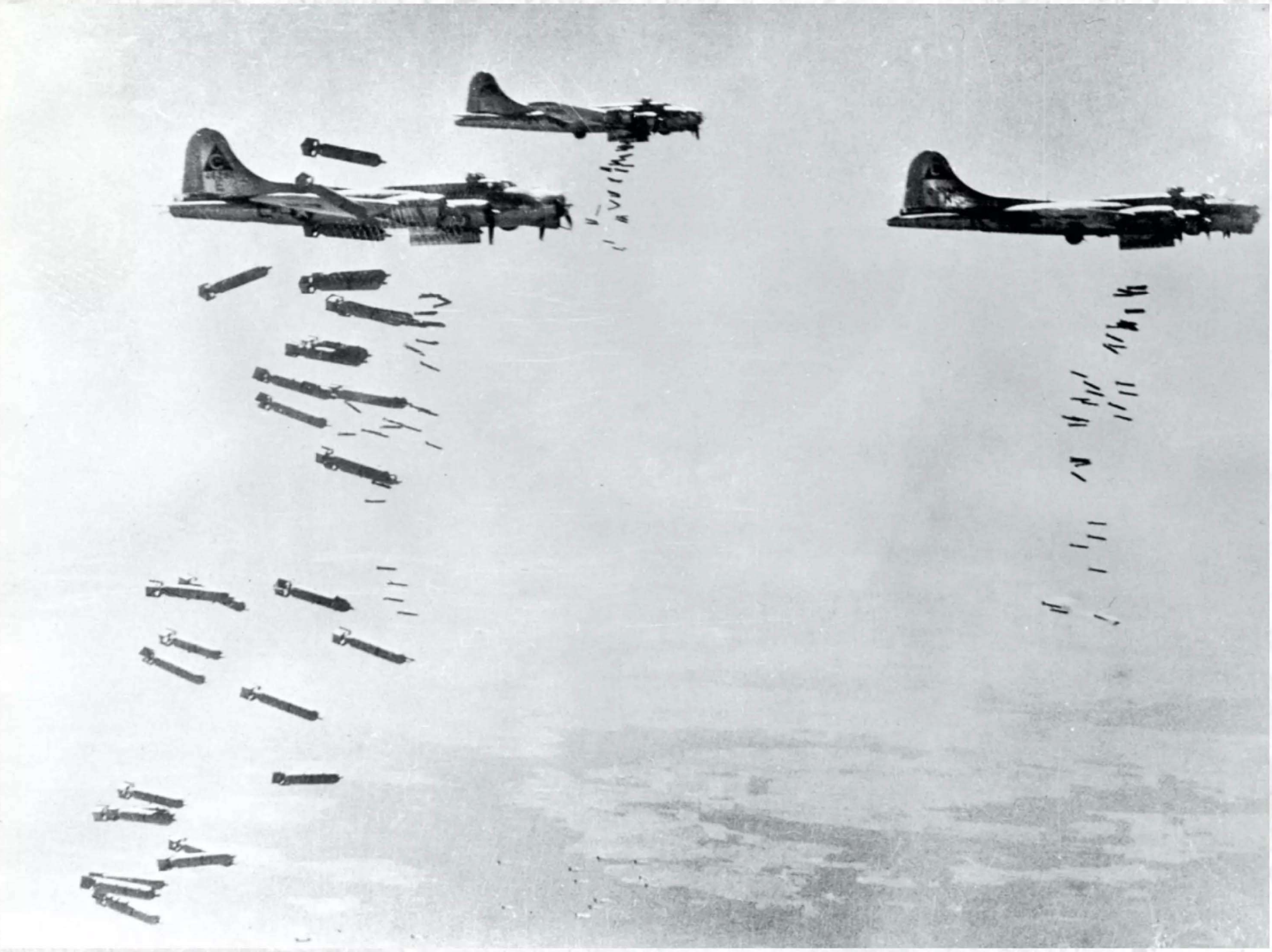
Soon, to minimize losses, the RAF switched from day to night attacks, and accuracy suffered further. In 1941, a survey reported that during this phase of the offensive, only one out of every three bombers managed to drop its bomb load within eight miles (13 kilometres) of its target.

In February 1942, the British government reappraised the role of Bomber Command. Precision attacks were deemed too difficult to carry out successfully; instead it was to focus on area bombing. The aim was to destroy the morale of the enemy populace, smash German industry and wear down their ability to make war. The morality of this decision – effectively putting German civilians in the front line of battle – was debated even at the time, and would continue to be controversial in the years that followed. The man charged with implementing this strategy was Bomber Command's new chief, Arthur Harris, a long-time believer in the war-winning potential of bombing. He presided over enormous expansion of the effort, including development and entry into service of new heavy bombers, application of science to the campaign in the form of better navigation and bomb-aiming equipment, and improvement in crew training.

The RAF did not fight alone. From August 1942, the might of the United States Army Air Forces (USAAF) was added to the battle. Their aircraft persisted with daylight raids, attempting to hit precision targets. The crews fought bravely, relying on the defensive armament of their bombers to force the giant formations through to the target. Losses were crippling, however, and the accuracy of the USAAF attacks was ultimately not as good as had been hoped.

It was not until 1943 that the bombing campaign began to have a serious impact on Germany. In January, a combined strategy was agreed by the British and American forces. Sites of submarine and aircraft production were targeted round the clock, then German fighter defences. The industrial cities of the Ruhr were attacked and then, in late 1943, Berlin itself. By the summer of 1944, Allied bombers had helped prepare the ground for D-Day and had achieved command of the skies over Germany. Attacks on oil and transport infrastructure in particular began to cripple the German war machine. Cities in the east were also targeted, in order to support the Soviet Union's war effort. One of the most controversial attacks of the whole campaign was launched in this phase of the battle – against Dresden in February 1945. The city was devastated and about 40,000 people were killed.

Dresden came to symbolize the horror of the strategic bombing campaign after the war. Many have argued that, even in a situation of "total war", the fact that so many people were killed was morally unacceptable. It was certainly costly for the Allies too – around 80,000 bomber crewmen lost their lives. The fact remains, however,



OPPOSITE LEFT: Wing Commander Guy Gibson (about to board the plane) and his crew board their Lancaster and prepare for the famous Dam Busters raid in May 1943. The attack on the dams of the Ruhr valley was devised by inventor Barnes Wallis. He developed a bouncing bomb to overcome the dam defences, which had to be delivered at very low level. A crack squadron (No. 617) was assembled, made up of the finest crews of Bomber Command. In May 1943 they successfully attacked and breached two of the dams, causing widespread damage. The raid gave a huge boost to British morale, but 53 out of the 133 men who took part were killed, and the Germans were quickly able to repair the damage that was done.

OPPOSITE RIGHT: The aftermath of the bombing of Dresden, Germany. On 13/14 February 1944, 796 Bomber Command Lancasters and 9 Mosquitoes raided the city, followed by 311 B-17s of the USAAF. The combination of explosives and incendiaries dropped caused firestorms, when the large number of burning buildings sucked in great draughts of oxygen, producing devastating gale-force winds to exacerbate the extreme temperatures. Many people were suffocated, adding to the numbers who were burned to death.

ABOVE: Boeing B-17 Flying Fortresses of the 303rd Bomb Group, December 1944. USAAF bombers flew in "box" formations, designed to maximise the defensive fire that could be brought to bear on an attacking fighter. It was not uncommon for aircraft below to be struck and destroyed by the bombs dropping from aircraft flying at a higher altitude.

The "Heavies"

Avro Lancaster and Boeing B-17 Flying Fortress

The stalwart of the RAF's campaign was the Avro Lancaster (above), the most successful of the three heavy bombers in British service. It could carry more and bigger bombs than any other aircraft in the campaign, and was loved by the crews who flew it. For the United States Army Air Forces (USAAF), the aircraft that came to symbolize the strategic bombing effort was the Boeing B-17 Flying Fortress. Packing a considerable punch thanks to its 0.50-inch (12.7-mm) machine guns, it could not match the Lancaster's payload.

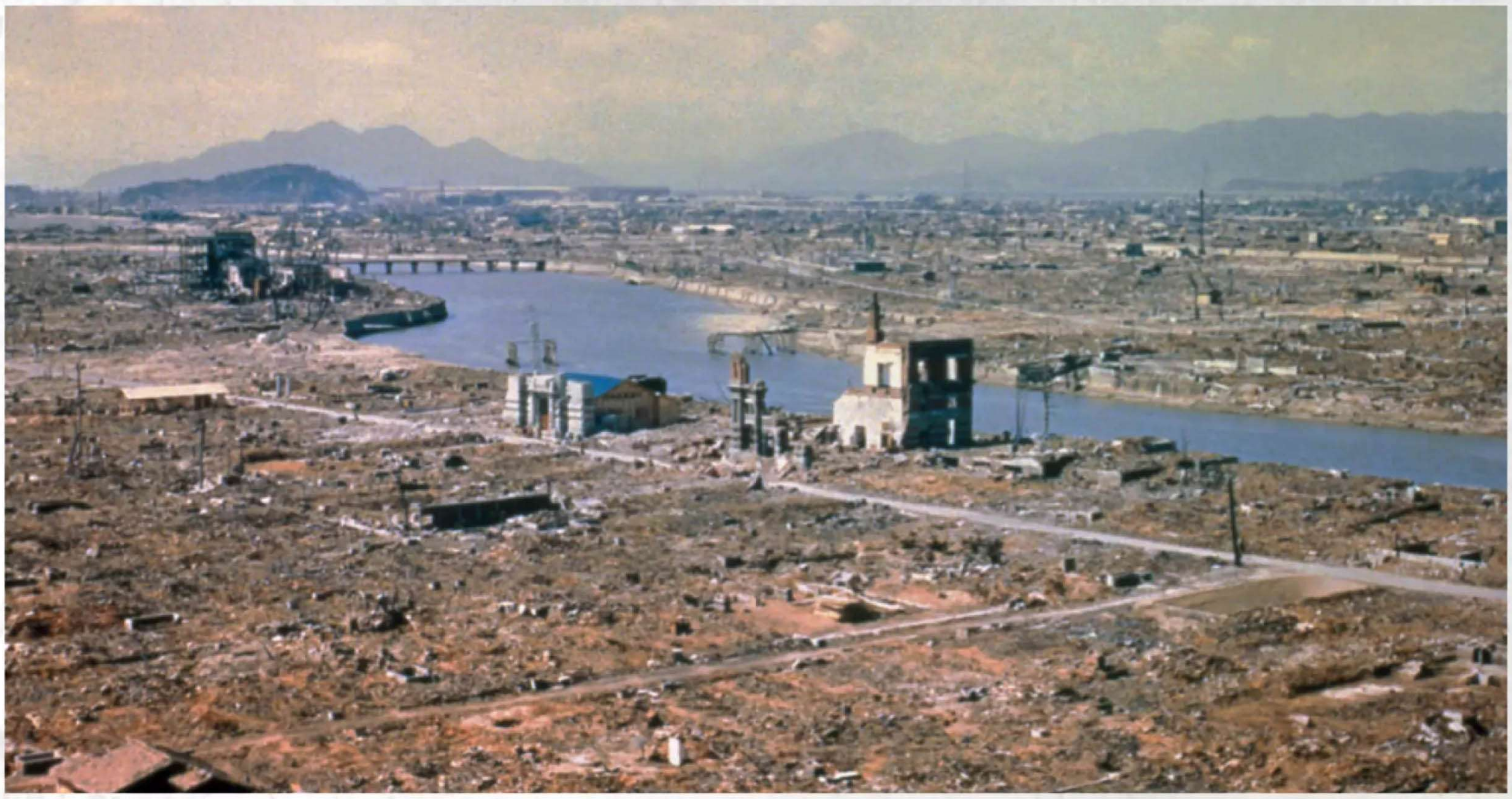
Sir Arthur Harris

(1892–1984)

Harris joined the Royal Flying Corps during the First World War, and became an exponent of the idea of strategic bombing in the newly formed RAF. He took over RAF Bomber Command in February 1942, and immediately put his stamp on the force with the first "thousand bomber raid" on Cologne in May. He oversaw the huge expansion of his command, and was convinced that his aircraft could deliver overall victory in the war. Although he was hugely respected by his men, he was perceived to be extremely stubborn. Even in the last months of the war, he was very reluctant to divert his forces away from the increasingly controversial area bombing campaign and on to operations of more tactical importance.

that although German industry was never completely smashed, and bombing alone did not win the war, the bombing campaign did have a serious effect on its eventual outcome. It kept about a million men and around 50,000 guns defending German cities and forced Germany to concentrate on air defence, rather than attack. Albert Speer, the German armaments minister who presided over German industrial expansion, called the campaign "the greatest lost battle on the German side".

Japan was spared the full force of a strategic bombing campaign until late in the war, primarily because of its location. But as soon as American B-29s became available, with their range of around 6,500 kilometres (4,000 miles), the USAAF began to strike at Japanese cities. By March 1945, American aircraft were dropping thousands of tonnes of incendiary bombs on cities such as Tokyo, causing huge fire storms. The raids had a significant effect on Japan's ability to continue the fight, even before atomic weapons were used on Hiroshima and Nagasaki in August. These two unfortunate cities would be forever associated with the ultimate destructive power of the bomber.



LEFT: Aerial view of Hiroshima, Japan, after the detonation of the first operational atomic bomb on 6 August 1945. The weapon, dubbed "Little Boy", exploded with the force of 12.5 kilotons of TNT. In total, around 140,000 people were killed by the blast and the subsequent fallout and radiation.

RIGHT: North American P-51 Mustangs of the 375th Fighter Squadron, 361st Fighter Group over England. The Mustang, with its Rolls-Royce Merlin engine and long-range fuel tank, provided the USAAF with a fighter that could escort the bomber streams all the way to their targets in Germany. Crucially, the Mustang also boasted exceptional performance characteristics that meant it was more than a match for the German air defence fighters such as the Bf 109.

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WORKING WITH THE ARMIES

In the early stages of the war, the Luftwaffe showed how air power could play a pivotal role in battle strategy. Over the next six years, the Allies built on the ground attack techniques perfected by the German air force and employed aircraft in a host of other duties that had a direct impact on the war on the ground.

Spotting for the artillery continued to be an important job for aircraft. German forces made great use of the very manoeuvrable Fieseler Storch and the Allies found that the Taylorcraft Auster and Piper Cub were suitable for the role that had proved so useful during the First World War.

Aerial reconnaissance proved vital to the outcome of the war. Alongside signals intelligence, photographic information obtained by aircraft provided the Allies with a war-winning edge over their enemies. The Luftwaffe were initially successful at obtaining photographic reconnaissance, but as the war progressed, their effectiveness decreased. The RAF developed fast unarmed aircraft to take photographs – adapted Supermarine Spitfires and de Havilland Mosquitoes – unarmed, stripped down and relying on speed. But the real key to British success was the interpretation skills of the analysts back on the ground.

The results of photo-reconnaissance missions were used by all branches of the armed forces. The United States adopted British techniques, developing reconnaissance

ABOVE: The view from a German observation aircraft, 1941–1942. Observation – be it local battlefield reconnaissance or spotting for the artillery – was an important duty for aircraft during the Second World War.

RIGHT: Soviet Ilyushin Shturmovik ground attack aircraft heading into battle. The Shturmovik was extremely important to the Soviet war effort. It possessed a tough, rugged airframe and armour, and could be equipped with bombs, rockets, machine guns and cannons. Over 37,000 were built.

OPPOSITE: US paratroopers jumping from their Douglas C-47 Skytrains, 1943. Troops jumped in groups or "sticks". Their parachutes were hooked up to a rail inside the aircraft by a static line; once they jumped, the cord would pull the parachutes from their packs automatically.

Sir Arthur Coningham
(1895–1948)

Sir Arthur Coningham served in the army and joined the RFC in 1916, flying fighters in France. After a successful inter-war RAF career, he led a Bomber Command Group, before taking command of the Western Desert Air Force in 1941.

His exceptional gifts as a leader and tactician were instrumental in creating a force which worked hand-in-hand with the army. He continued to prove his abilities in Tunisia, Sicily and Italy, and in 1944 commanded the Allied Second Tactical Air Force from D-Day to the final defeat of Germany. He was tragically killed in an air accident three years after the end of the conflict at the age of 53.

versions of the P-38 Lightning and P-51 Mustang. The culmination of photo-intelligence efforts came on D-Day in June 1944: more than 4,500 photo-reconnaissance missions were flown to prepare for the launch of Operation "Overlord".

At the start of the war, the RAF was a long way behind the Luftwaffe when it came to direct battlefield support, having focused much of its efforts in the inter-war period on the idea of strategic bombing and home defence. It was not until the desert campaigns of 1941 that the RAF achieved real success in this area, when Hawker Hurricanes fitted with bombs were used to attack targets close to or on the front line. The key was the development of good air-to-ground communications systems, which allowed controllers on the ground to call in aircraft where needed. The Western Desert Air Force had a huge effect on the outcome of the key battles of 1942, and on through into Italy. Following these successes, the Allies converted the Republic P-47 and Hawker Typhoon into rugged fighter bombers, equipped with rockets and bombs. These aircraft were vital in the campaign in northern Europe, where the Second Tactical Air Force provided close air support for the advancing armies.

On the Eastern Front, the Soviet Red Army used its aircraft predominantly to assist the troops on the ground, attacking tanks, troops and communications. The IL-2 Shturmovik was the classic ground attack aircraft, so important to the success of the campaigns in the east that Marshal Joseph Stalin stated in 1941 that "The Red Army needs the Il-2 as it needs air and bread".

Germany developed the idea of "airborne warfare" based on experiments carried out by the Soviets in 1922. The idea was to drop troops by parachute or in gliders behind the lines, to cause shock and surprise or to capture an important target, then hold out until relieved by the advance of conventional troops. They were first used in Norway and the Allies soon adopted the idea. German airborne troops proved effective in the invasion of Crete in 1941 (although the high number of casualties dissuaded the German high command from using them again), and Allied operations began in North Africa in 1942, then Sicily in July 1943. In 1944, Allied paratroopers and glider-borne infantry secured the flanks on D-Day, fought in Holland and then in 1945 spearheaded the advance over the Rhine.

Transport aircraft were also vital to the success of several campaigns, most notably in the China-Burma-India theatre. The Allied 14th Army relied on air transports as they advanced through Burma and the famous "Chindits" – the troops who fought behind Japanese lines – were supplied by air. The air route into southwest China known as the "Hump" kept Chinese and US forces fighting, and there were many other operations that could only take place thanks to the flexibility offered by the transports.

Pierre Henri Clostermann
(1921–2006)

Clostermann (left) was one of the most successful ground attack pilots of the Second World War. He was born in Brazil and after being educated in Paris, obtained his private pilot's license in 1937. After the war broke out, he spent some time studying in the United States, before joining the Free French Air Force. He soon proved his abilities as a fighter pilot, flying firstly with No. 341 "Alsace" Squadron, then with No. 602, flying ground-attack missions.

After an enforced break from operations, Clostermann returned to service and flew the powerful RAF Tempest on missions supporting the advance across France and into Germany. After the war, he would go on to work in business and politics and even re-enlisted in the air force in 1956 to fly on operations in Algeria.

German military vehicles destroyed by British rocket-firing Hawker Typhoons. Although the Typhoon was designed as a fighter, with its robust construction and high speed at low-level it found its true calling when used as a ground attack aircraft.

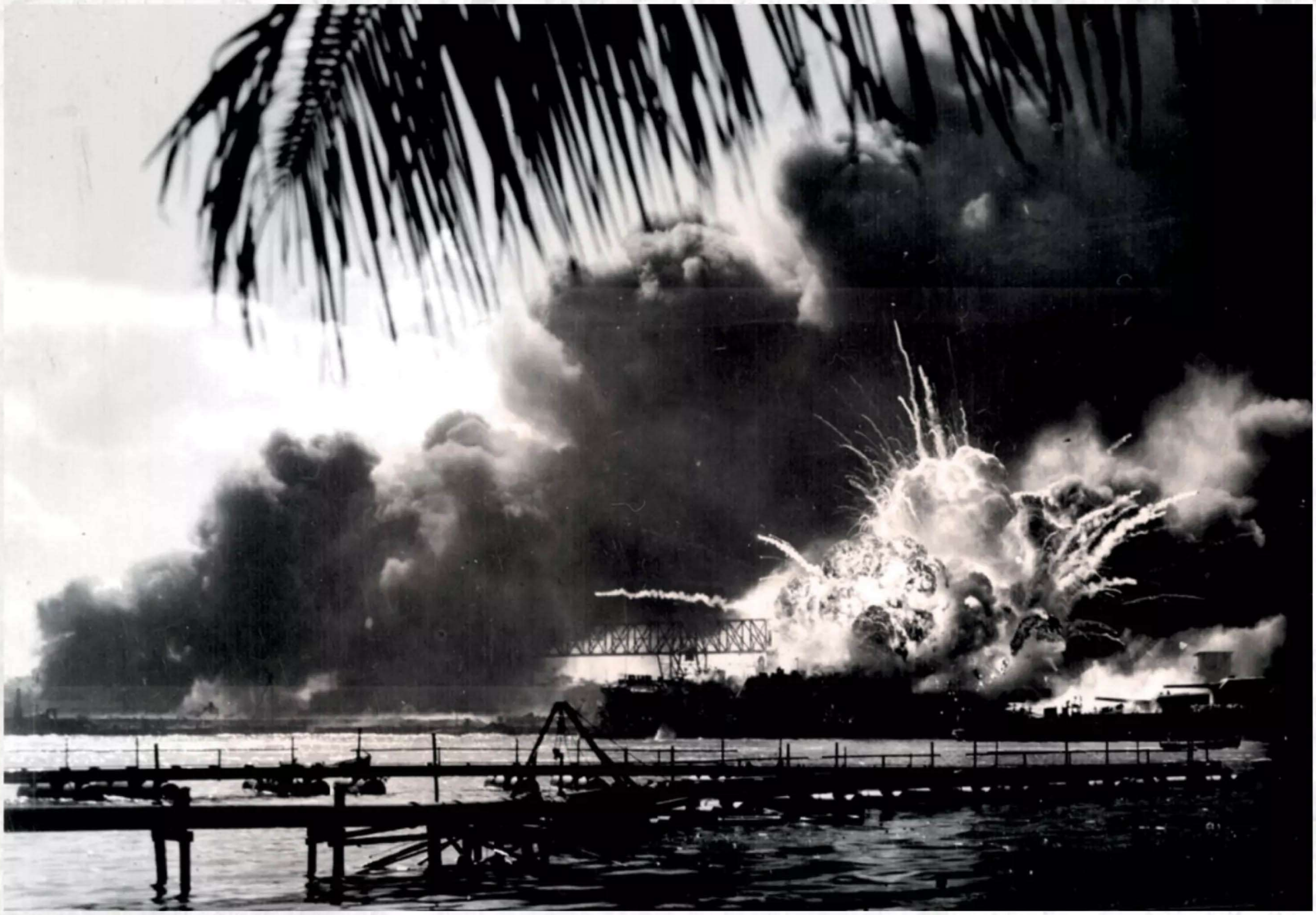
THE AIR WAR AT SEA

With the possible exception of the submarine and torpedo, nothing did more than aviation to revolutionize war at sea. Maritime patrol aircraft kept watch over precious Atlantic convoys; carrier-launched torpedo bombers effectively ended the dominance of the battleship, and demonstrated that there were few places — and certainly no naval vessels — immune from attack.

The aircraft's ability to see over the horizon, harking back to the artillery spotting duties of the First World War, continued to be vital even in "traditional" big-gun naval actions, such as the Battle of the River Plate in 1939, when a Fairey Seafox launched by HMS Achilles helped the cruiser's guns target the Graf Spee pocket battleship. Catapult-launched seaplanes were an important addition to most large surface vessels for just this purpose. Large flying boats, with their fantastic endurance (the American PBY Catalina could stay airborne for 24 hours) provided anti-submarine patrols, particularly helping to protect vital convoys on their way across the oceans. Land-based maritime patrol aircraft, such as the Consolidated Liberator, helped turn the tide in the pivotal Battle of the Atlantic in 1943.

Even the mightiest surface warships bristling with anti-aircraft weaponry were vulnerable to the threat from the air. The German battleship Bismarck, one of the most powerful vessels afloat, was crippled by a torpedo from a Fairey Swordfish biplane from HMS Ark Royal in November 1940, leading to her eventual destruction. In the Mediterranean, the British effectively knocked the Italian surface fleet out of the war in 1940 when 21 Swordfish from HMS Illustrious severely

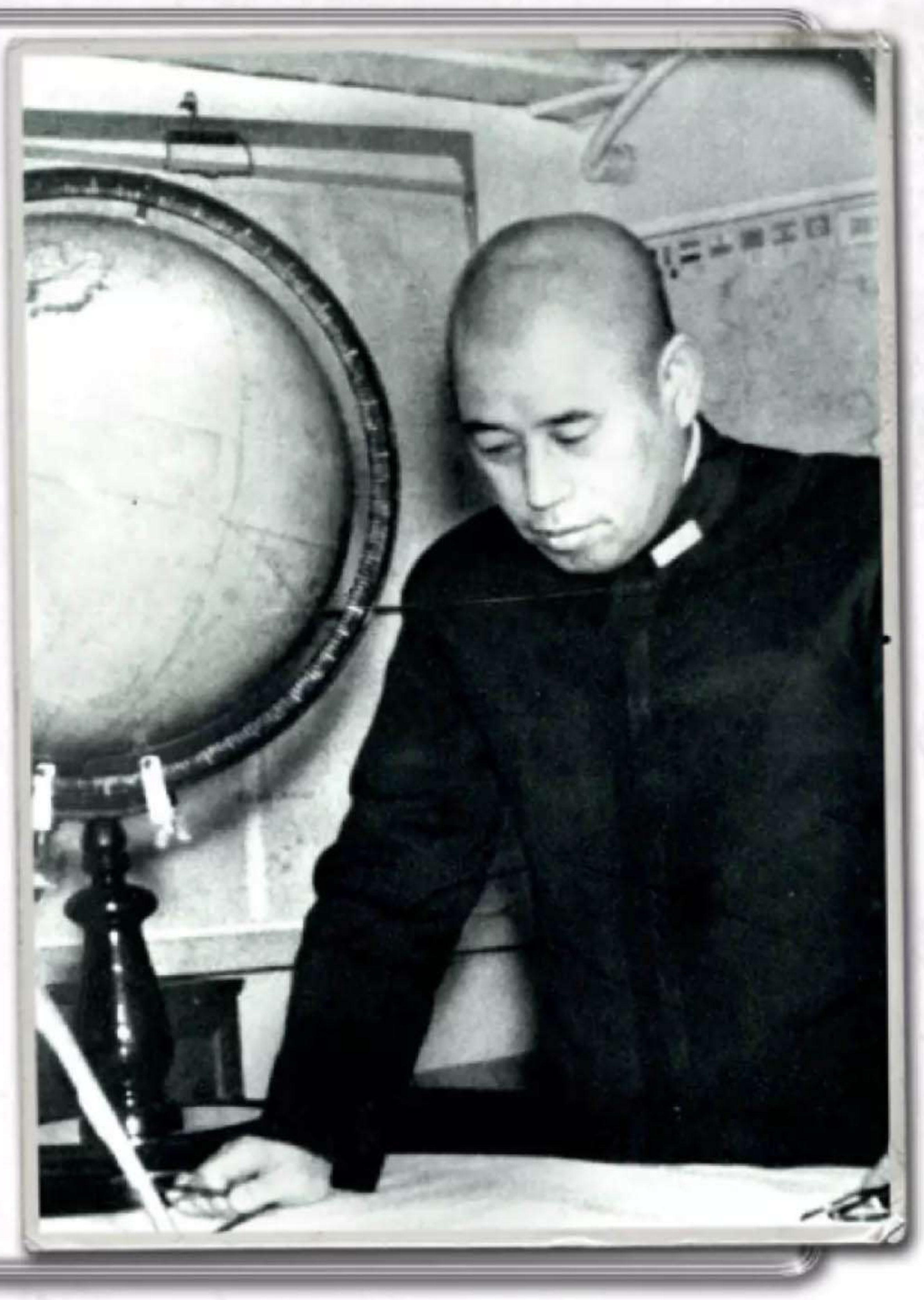
BELOW: SUSS Yorktown, April 1942. This vessel was able to carry approximately 100 aircraft, measured nearly 250 metres (820 feet) in length and was one of over 120 US carriers of different sizes. Carriers were built by three of the main combatants – the United States, Britain and Japan.



ABOVE: USS Shaw explodes at Pearl Harbor. Altogether nearly 2,500 military personnel and civilians were killed in the surprise Japanese attack. Although the victory was a significant short-term gain for the Japanese, it served to unite the American people and ultimately led to the defeat of the Japanese in the Pacific.

Admiral Isoroku Yamamoto
(1884–1943)

Yamamoto understood the potential of naval aviation better than most. From the mid 1920s he was closely involved with carriers and aircraft. He oversaw the development of the Zero fighter, and unlike many of his rank in navies around the world, had little or no faith in battleships, being certain that the future belonged to the aircraft carrier. Although he opposed those who were calling for war, he masterminded what he saw as Japan's best hope for victory in the Pacific – a sudden, pre-emptive strike at the US fleet at Pearl Harbor. Although he never again achieved the same level of success, his abilities were respected by both the Japanese and Americans. He was killed in April 1943, when Allied intelligence revealed his whereabouts and a flight of American P-38 Lightnings were sent to shoot down his aircraft.

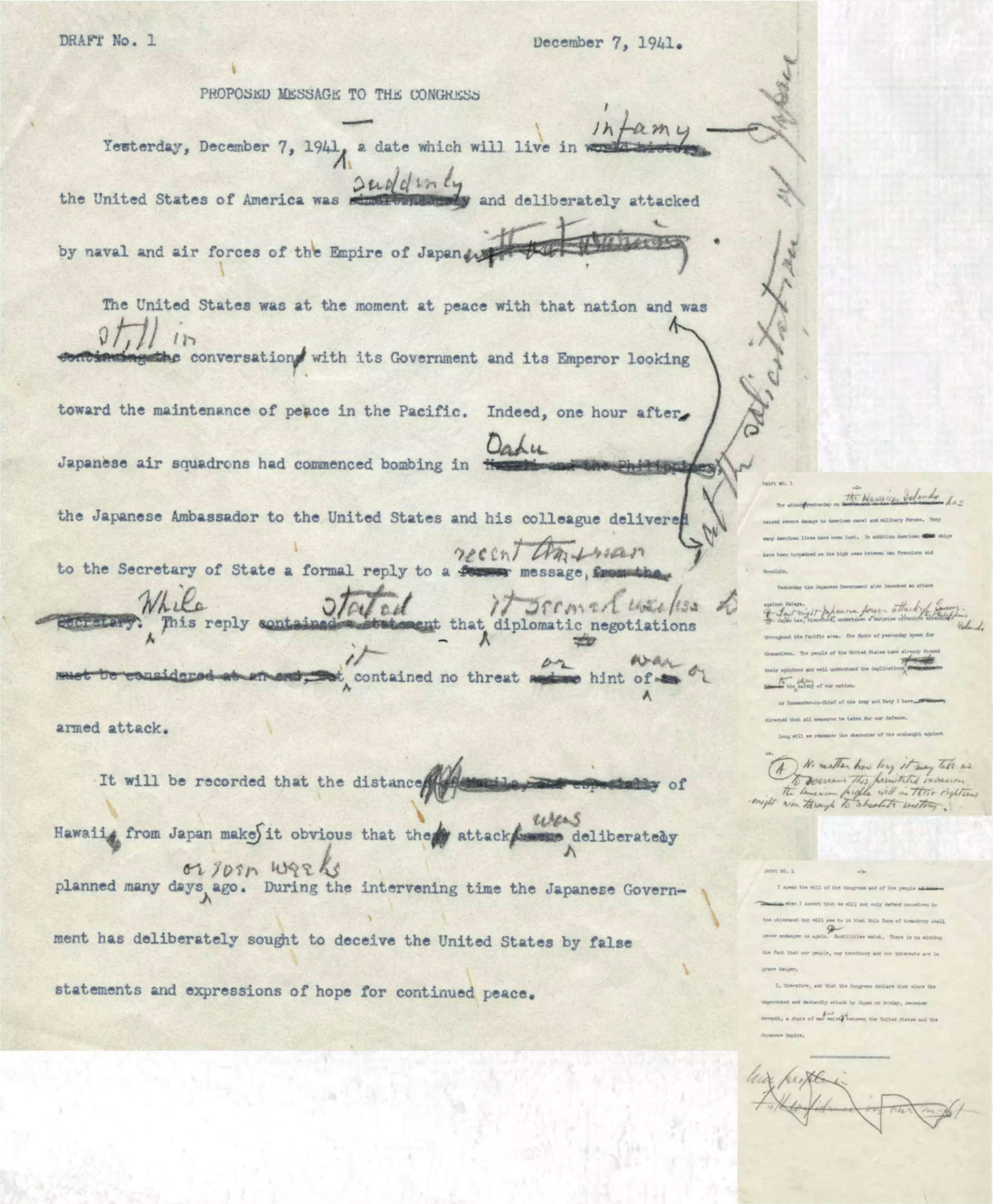


damaged three battleships and a cruiser at Taranto harbour.

The Japanese high command was quick to see the potential of a surprise, carrier-launched attack on unsuspecting vessels in harbour as a way of dramatically shifting the balance of power in the Pacific away from the United States. Drawing in part on the lessons of Taranto, they planned a devastating attack on Pearl Harbor, home of the US Pacific Fleet. With highly trained pilots and well-developed weapons, the Japanese stunned the world in December 1941. For the loss of 29 aircraft, they seriously damaged or sunk a total of 18 American vessels. As well as

A United States Navy Consolidated PB4Y-1 Liberator on an anti-submarine patrol over the Bay of Biscay. Such aircraft played a vital role in winning the Battle of Atlantic against the U-boats that threatened Allied convoys.

B-3



DRAFT No. 1 December 7, 1941.

PROPOSED MESSAGE TO THE CONGRESS

Yesterday, December 7, 1941, a date which will live in ~~world history~~ infamy the United States of America was ~~simultaneously~~ suddenly and deliberately attacked by naval and air forces of the Empire of Japan ~~without warning~~.

The United States was at the moment at peace with that nation and was at the solicitation of Japan ~~continuing the~~ still in conversations with its Government and its Emperor looking toward the maintenance of peace in the Pacific. Indeed, one hour after Japanese air squadrons had commenced bombing in ~~Hawaii and the Philippines,~~ Oahu the Japanese Ambassador to the United States and his colleague delivered to the Secretary of State a formal reply to a ~~former~~ recent American message, ~~from the Secretary~~. While this reply ~~contained a statement~~ stated that it seemed useless to diplomatic negotiations ~~must be considered at an end, but~~ it contained no threat ~~and no~~ or hint of war or ~~an~~ armed attack.

It will be recorded that the distance ~~of Manila, and especially~~ of Hawaii, from Japan makes it obvious that the attack ~~were~~ was deliberately planned many days or even weeks ago. During the intervening time the Japanese Government has deliberately sought to deceive the United States by false statements and expressions of hope for continued peace.

DRAFT NO. 1 -2-

The attack yesterday on ~~[illegible]~~ the Hawaiian Islands has caused severe damage to American naval and military forces. Very many American lives have been lost. In addition American ~~[illegible]~~ ships have been torpedoed on the high seas between San Francisco and Honolulu.

Yesterday the Japanese Government also launched an attack against Malaya.

¶ Last night Japanese forces attacked Guam. the Philippine Islands

¶ Japan has, therefore, undertaken a surprise offensive extending throughout the Pacific area. The facts of yesterday speak for themselves. The people of the United States have already formed their opinions and well understand the implications ~~[illegible]~~ to the very safety of our nation.

As Commander-in-Chief of the Army and Navy I have ~~[illegible]~~ directed that all measures be taken for our defense.

Long will we remember the character of the onslaught against us.

Ⓐ No matter how long it may take us to overcome this premeditated invasion, the American people will in their righteous might win through to absolute victory.

DRAFT NO. 1 -3-

I speak the will of the Congress and of the people ~~of this nation~~ when I assert that we will not only defend ourselves to the uttermost but will see to it that this form of treachery shall never endanger us again. ¶ Hostilities exist. There is no mincing the fact that our people, our territory and our interests are in grave danger.

I, therefore, ask that the Congress declare that since the unprovoked and dastardly attack by Japan on Sunday, December seventh, a state of war ~~exists~~ has existed between the United States and the Japanese Empire.

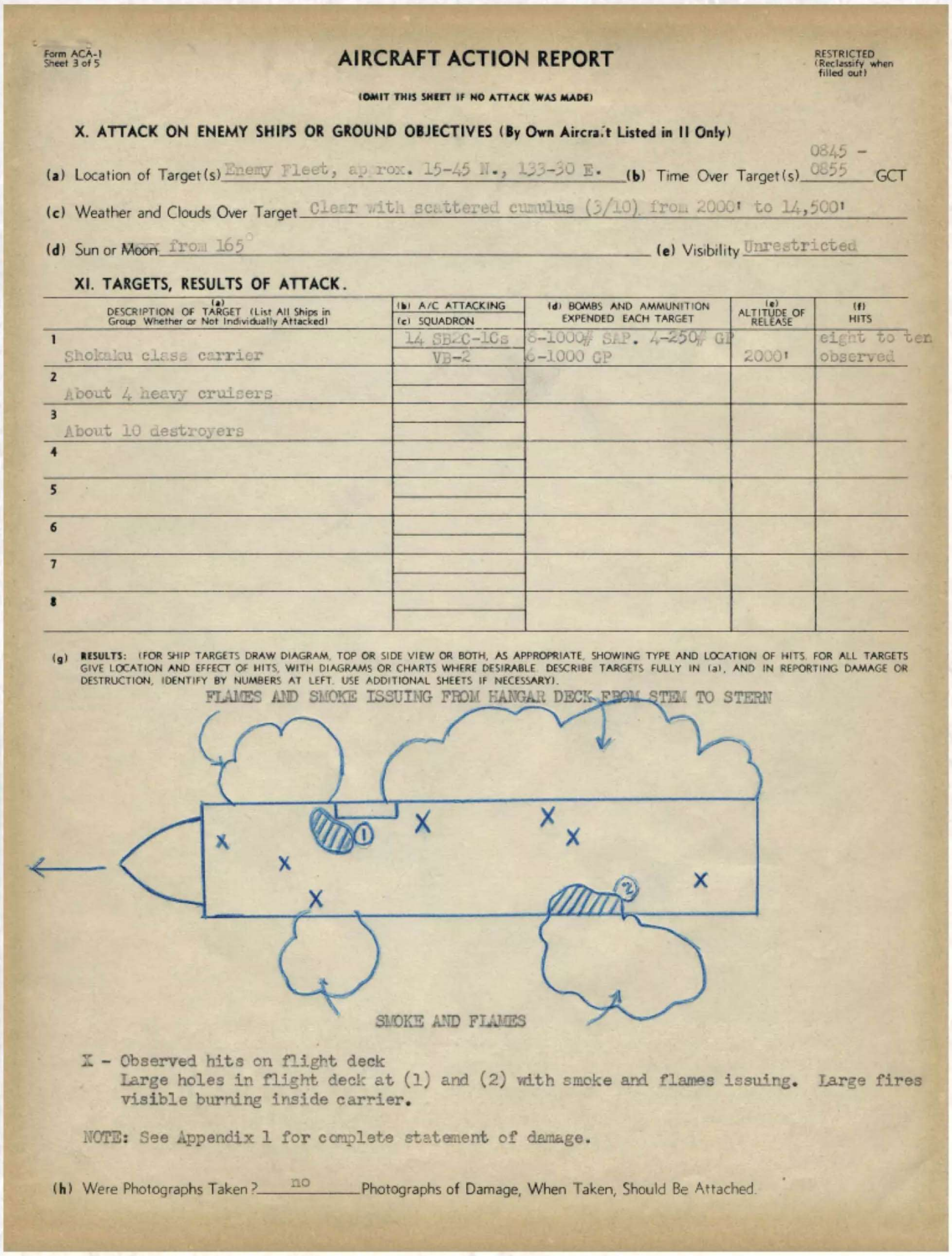
==========================

~~With confidence in our [illegible]~~

drawing the United States into the war, the attack demonstrated beyond all doubt the importance of carrier-borne aircraft. Luckily, the American carriers were not at Pearl Harbor on the day of the attack, and they would soon assume huge importance as the war in the Pacific began in earnest.

The Battle of the Coral Sea in May 1942 showed just how much the aircraft carrier had supplanted the battleship as the most important warship in the fleet. For the first time in history, a major battle between two large fleets of ships was fought using aircraft alone, as bombers from the USS Yorktown and Lexington exchanged blows with the Japanese carriers Shōkaku and Zuikaku. There were other ships in the fleets, but their role was peripheral. Coral Sea was followed by an even more significant battle: in June 1942, American aircraft – particularly Douglas Dauntless dive-bombers – destroyed four Japanese carriers that had been sent to win air superiority over the island of Midway. Like the Battle of the Coral Sea, Midway was fought by aircraft, well beyond the range of traditional guns.

The Allies went on the offensive in the Pacific, and at the heart of their efforts were the carriers and their precious aircraft. Fleets were organized around these vital ships. In 1944, in the Battle of the Philippine Sea in June, and the Battle of Leyte Gulf in October, the US Navy's aircraft once and for all asserted their dominance over the Japanese fleet, using aircraft to destroy their carriers. The employment of kamikaze tactics, when Japanese pilots used themselves and their aircraft as guided weapons, caused some considerable damage to the Allies however, sinking or damaging over 300 vessels. Ultimately, though these costly attacks could not be sustained.



Form ACA-1
Sheet 3 of 5

AIRCRAFT ACTION REPORT

RESTRICTED
(Reclassify when filled out)

(OMIT THIS SHEET IF NO ATTACK WAS MADE)

X. ATTACK ON ENEMY SHIPS OR GROUND OBJECTIVES (By Own Aircraft Listed in II Only)

(a) Location of Target(s) Enemy Fleet, approx. 15-45 N., 133-30 E. (b) Time Over Target(s) 0845 - 0855 GCT

(c) Weather and Clouds Over Target Clear with scattered cumulus (3/10) from 2000' to 14,500'

(d) Sun or ~~Moon~~ from 165° (e) Visibility Unrestricted

XI. TARGETS, RESULTS OF ATTACK.

	(a) DESCRIPTION OF TARGET (List All Ships in Group Whether or Not Individually Attacked)	(b) A/C ATTACKING (c) SQUADRON	(d) BOMBS AND AMMUNITION EXPENDED EACH TARGET	(e) ALTITUDE OF RELEASE	(f) HITS
1	Shokaku class carrier	14 SB2C-1Cs VB-2	8-1000# SAP. 4-250# GP 6-1000 GP	2000'	eight to ten observed
2	About 4 heavy cruisers				
3	About 10 destroyers				
4					
5					
6					
7					
8					

(g) RESULTS: (FOR SHIP TARGETS DRAW DIAGRAM, TOP OR SIDE VIEW OR BOTH, AS APPROPRIATE, SHOWING TYPE AND LOCATION OF HITS. FOR ALL TARGETS GIVE LOCATION AND EFFECT OF HITS, WITH DIAGRAMS OR CHARTS WHERE DESIRABLE. DESCRIBE TARGETS FULLY IN (a), AND IN REPORTING DAMAGE OR DESTRUCTION, IDENTIFY BY NUMBERS AT LEFT. USE ADDITIONAL SHEETS IF NECESSARY).

FLAMES AND SMOKE ISSUING FROM HANGAR DECK FROM STEM TO STERN

SMOKE AND FLAMES

X - Observed hits on flight deck
Large holes in flight deck at (1) and (2) with smoke and flames issuing. Large fires visible burning inside carrier.

NOTE: See Appendix 1 for complete statement of damage.

(h) Were Photographs Taken? no Photographs of Damage, When Taken, Should Be Attached.

Admiral Chester Nimitz

(1885–1966)

Nimitz was in overall command of the US Pacific Fleet after Pearl Harbor, and masterminded the Allied victory over the Japanese in the Pacific. It was Nimitz who gave approval for the Doolittle Raid on Tokyo, launched in April 1942 as a direct retaliation for Pearl Harbor, and he planned the Battle of Midway, the carrier action that, along with the invasion of Guadalcanal in August 1942, marked the turning point in the campaign. Like Admiral Yamamoto, he understood the importance of the aircraft carrier, and also made the best use of the intelligence material available to give him and his command the edge over a well-prepared enemy.

OPPOSITE: President Franklin D Roosevelt's message to Congress after the Japanese attack on Pearl Harbor. Roosevelt went to Congress seeking its approval to declare war. The US Senate approved 82 votes to 0 and the House of Representatives voted in favour 388-1.

LEFT: Aircraft Action Report from a Curtiss Helldiver squadron operating from USS Hornet. It describes the action of 20 June 1940 during the Battle of the Philippine Sea, when over 200 US carrier aircraft attacked a Japanese carrier group, sinking the Hiyó.

INDUSTRY AND NEW TECHNOLOGIES

The Second World War forced the richest nations on earth to direct the vast majority of their industrial and scientific resources into producing military equipment. The level of achievement of the men and women in the factories and the scientists and engineers in countless design offices and laboratories was staggering. Warfare always acts as an accelerator for development, and the largest conflict in the history of mankind prompted unprecedented leaps forward. With the appearance of the jet engine and radar, rockets and nuclear weapons, no field was as affected as much as aviation.

Aircraft production by the Axis powers (Germany, Italy and Japan) was not able to match that of the Allies, a crucial reason for the ultimate outcome of the war. In 1938, Britain manufactured fewer than 3,000 military aircraft. By 1944, the UK was producing 26,000 machines annually. In the United States, the expansion was even more impressive. Fewer than 2,000 aircraft were built in American factories in 1938, but during 1944 this figure increased to over 96,000. By the end of the war, Allied aircraft were outnumbering enemy aircraft in all theatres of conflict by a ratio of at least 5 to 1. This unprecedented growth involved the use of a wide range of existing factories, the construction of many new purpose-built sites and the recruitment of thousands of women into the plants. All of this would give aviation an enormous boost in peacetime.

It was not just the volume of production that defeated Nazi Germany. Continued technological development was key to maintaining control of the skies. In this area, Germany threatened at first to match and even surpass Allied inventions. The Nazi regime invested a great deal of money and effort in experimental projects which they hoped would produce a "wonder weapon" that could win the war. Although some incredible advances were made (for example, rocket engines), they came too late to have any effect on the eventual outcome of the conflict. But the German research was to prove vital to the future post-war development of space rockets, missiles

RIGHT: The VS-300, created by Igor Sikorsky, became the first successful helicopter after its historic tethered flight on September 14, 1939. The following spring, the helicopter could stay airborne for as long as 15 minutes, and in 1941 it established a world record world a flight of 1 hour, 32 minutes, and 26 seconds.

Igor Sikorsky
(1889–1972)

Sikorsky was born in Kiev. Throughout his childhood he was fascinated by aviation, particularly the concept of a helicopter. In 1913, he designed and built giant four-engine aeroplanes – the first such machines ever to fly. He became famous for his 2,600-kilometre (1,600-mile) flight from St Petersburg to Kiev in 1914 in the four-engined Il'ya Muromets. After moving to America to escape the revolution, Sikorsky built flying boats before turning his attention once again to helicopters. His breakthrough idea was to position a small vertical rotor on the tail to counteract the torque of the main rotor. This configuration can be seen on most modern helicopters.

and record-breaking aircraft (such as the formidable sound-barrier-smashing Bell X-1, flown by Chuck Yeager in 1947).

The jet engine was born simultaneously in Britain and Germany in the 1930s. In the United Kingdom, Frank Whittle developed the turbojet that would go on to power the Gloster Meteor. In Germany, it was Hans von Ohain whose work led to the creation of a functioning turbojet. Following Germany's defeat, it was left to Britain to lead the world in this exciting new technology. Soon however, America and the Soviet Union also began making great strides forwards in jet engine development. Other European designers rapidly caught up as well, most notably the French with the jet-powered Dassault Ouragan fighter.

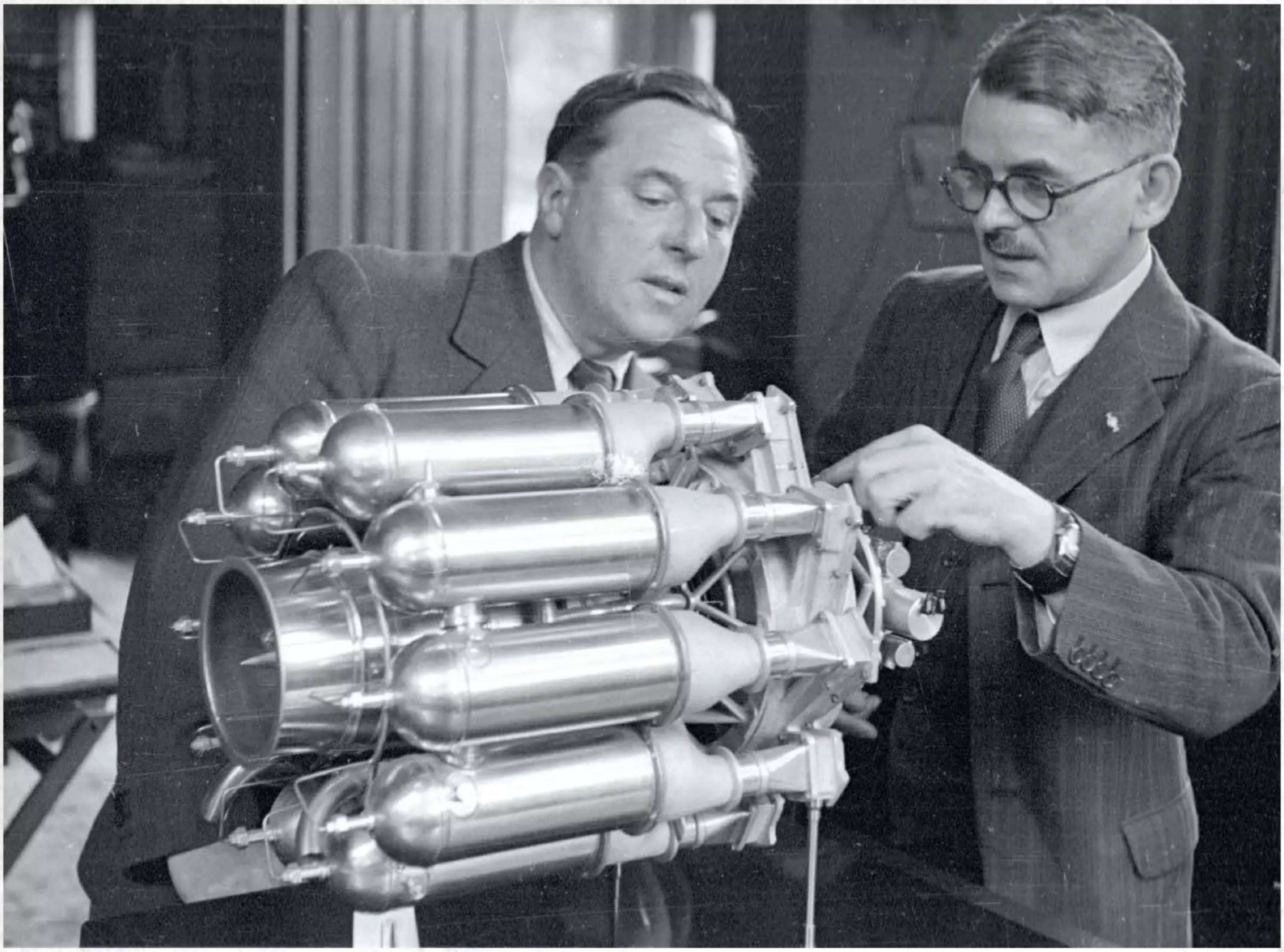
Radar had an enormous impact on aviation. In 1935, Robert Watson-Watt led the research in Britain that created the radio-wave device that could detect aircraft at great range. Parallel research was being conducted in Germany too, leading to similar systems. Radar would form the basis of many of the technologies that were vital to the development of aviation in the second half of the twentieth century, including military weapons systems and civil air traffic control.

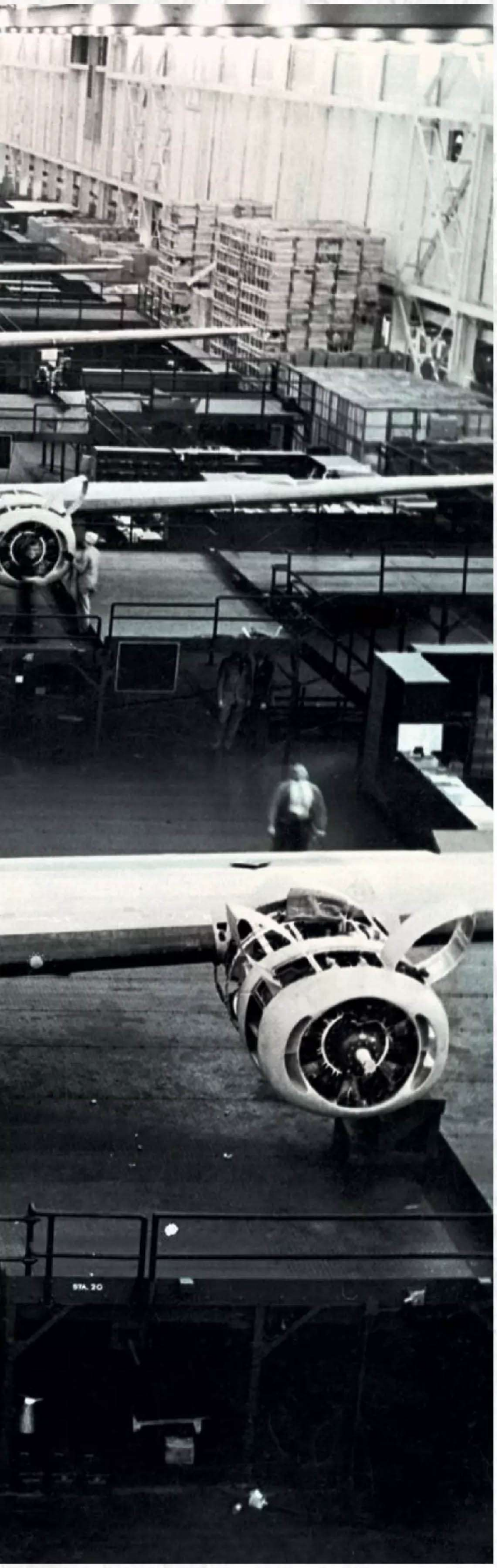
Helicopters first entered service in the Second World War, but the compromise between the helicopter and fixed wing aircraft, the autogyro, was originally pioneered in the 1930s. Many engineers around the world worked on true vertical take-off machines, including Louis Breguet of France and the German, Heinrich Focke. However, the man most associated with the genesis of the helicopter is Igor Sikorsky, whose VS-300 led to the world's first production helicopter, the R-4 Hoverfly, used by the Allies in significant numbers after 1942.

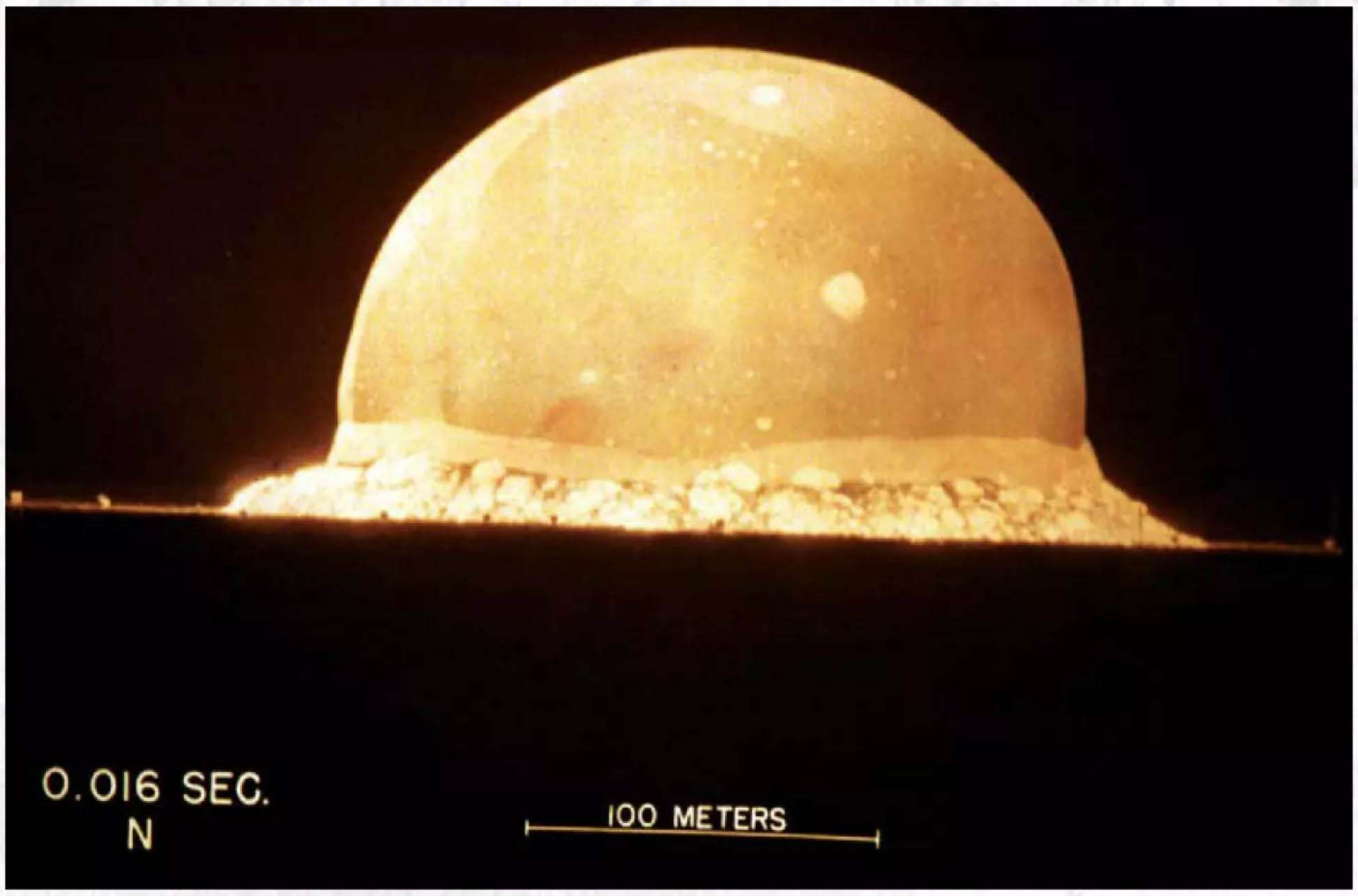
The creation and use of the atomic bomb would shape the future of aviation as much as any other technology. Aircraft were tasked with delivering these devastating weapons, and the Cold War was defined by their ability to drop them on cities thousands of kilometres away.

OPPOSITE: Women work on the production line of Hawker Hurricanes. By 1943 over seven million British women were in paid work, carrying out many of the "home front" duties that had once been the preserve of men.

BELOW: Sir Frank Whittle (1907–1996), right, pioneer of the jet engine, explains the workings of a turbojet. Whittle joined the RAF in 1923 as an engineer apprentice, before becoming a pilot and an officer. His initial idea for a turbojet was rejected by the Air Ministry, but with the backing of the RAF, Whittle continued his engineering studies, subsequently founding the company Power Jets in 1936 in order to develop his designs.







ABOVE: The first atomic bomb test was carried out in New Mexico, USA, on 16 July 1945. It was developed by a team of scientists under the direction of J Robert Oppenheimer. The project was codenamed "Manhattan".

LEFT: Consolidated B-24 bombers at Henry Ford's Willow Run plant, February 1943. The United States' industrial might far outstripped that of any other nation. The Willow Run factory alone was 1.6 kilometres (0.9 miles) long and nearly 400 metres (1,312 feet) wide, and produced over 8,500 aircraft. By the middle of 1945 the US aviation industry was using nearly 15 million square metres (161 million square feet) of space across the country.

Marcel Dassault
(1892–1986)

Born Marcel Bloch, Dassault changed his name after the Second World War. Dassault had been the wartime resistance codename of his brother Paul. Before the Second World War, Bloch had been involved in the design of several military and civil aircraft and after 1940 he joined the resistance. He was captured in 1944 and imprisoned in Buchenwald concentration camp. After the war, Dassault spearheaded the design of many outstanding aircraft, including the Mystère and the Mirage. He is widely regarded as responsible for the growth and success of the post-war French aircraft industry.

AIR TRAVEL IN THE POST WAR WORLD

Before the Second World War, air travel was a growing but hardly practical alternative to traditional forms of transport. After it, air travel began to shrink the world. This was caused by several factors. Great technological strides were made in aircraft development, including sophisticated navigation and communications equipment. The war created a large group of people around the world very familiar with aircraft and aviation — including thousands of ex-military aircrew and ground crew — and a network of former wartime airfields was scattered all over the globe, ready to be converted into airports. Particularly in the United States, the massive industrial effort that had produced over 300,000 combat aircraft could easily be switched to manufacturing commercial aircraft. Where this was not possible, there were military transport designs that could be easily converted, as happened in Britain.

International agreement was needed to control all of this. The 1944 Chicago Convention, at which over 50 nations were represented, updated the many bilateral agreements that had previously governed international flight. While it did not completely open up the skies, it did set a framework that allowed air travel to expand and develop. The International Air Transport Association (IATA), established in 1949, governed international air routes and regulated what could and could not be charged for flights. Most airlines were heavily subsidized or owned by their national governments – so-called "national carriers".

In the United States, undoubtedly the world leader in civil aviation, the government saw to it that competition between the major airlines was controlled. Pan American, American Overseas Airways, Transcontinental and Western Airlines (TWA – which after 1950

RIGHT: Baggage is loaded into a British Overseas Airways Corporation (BOAC) Avro Lancastrian airliner in the 1940s. The Lancastrian is an example of an ex-military aircraft being successfully adapted for civilian use, based as it was on the Avro Lancaster bomber. It served on several routes, including Britain to Australia, and the type carried both passengers and mail.

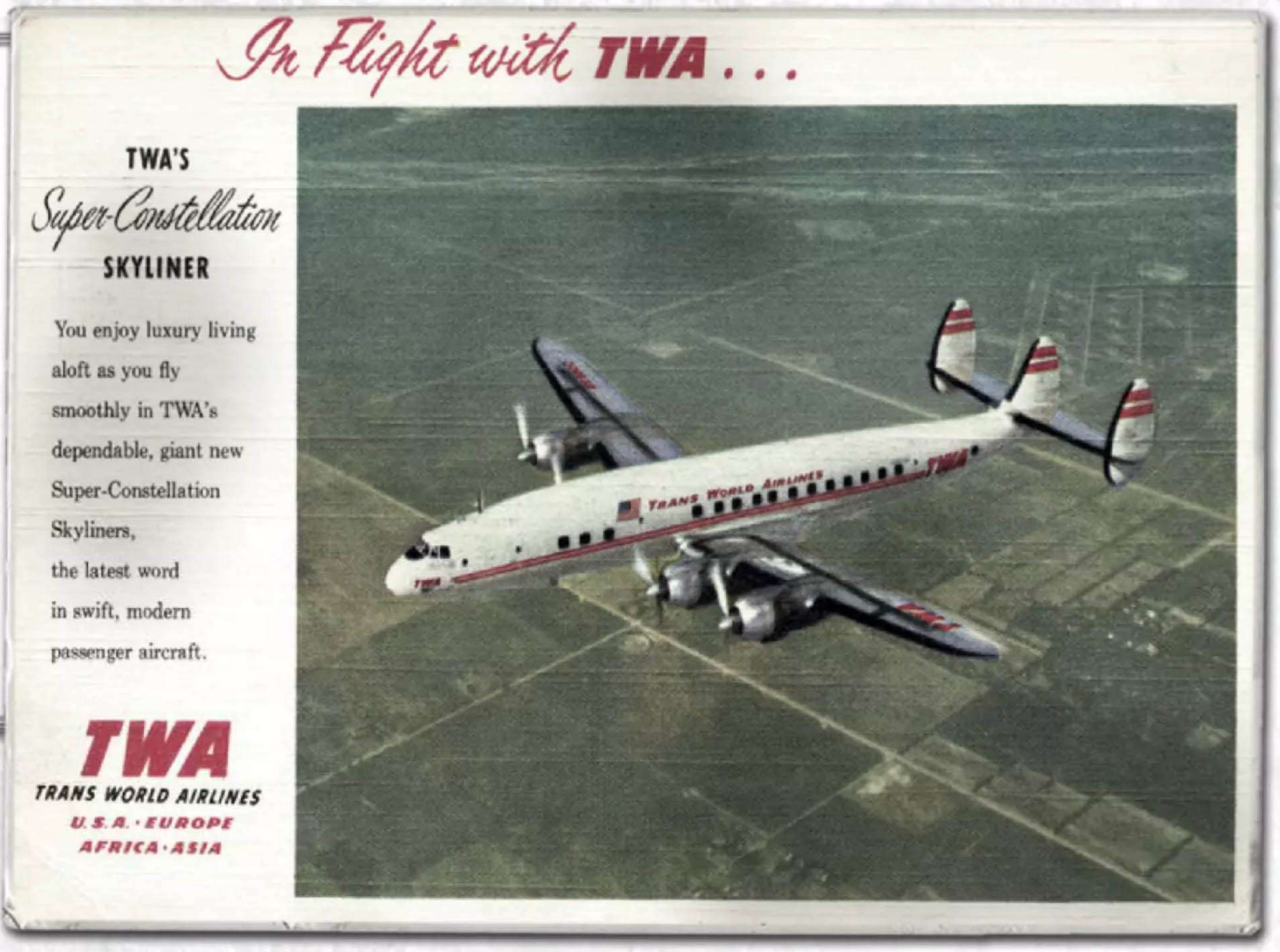
OPPOSITE: The Boeing Stratocruiser Flying Cloud at Heathrow, London, April 1949, after completing its first transatlantic flight. The Stratocruiser was purposely named to reflect the fact that with its pressured cabin, it could cruise in the stratosphere, above any turbulent weather. It was essentially a newly designed double-deck fuselage with the wings and tail of a B-29 bomber.

PAN AMERICAN WORLD AIRWAYS
Clipper Flying Cloud
PAA
N1026V
SPEED LIMIT
15 MPH

7c
PH-DSP
DE VLIEGENDE HOLLANDER
KLM

The Lockheed Constellation series

Constellations are widely regarded as some of the most beautiful airliners ever built. Designed by Clarence "Kelly" Johnson, the first variant in the series, the L-049, was requisitioned for military transport use during the Second World War and designated the C-69. After the war the design was developed further into the ultimate version, the L-1049 Super-Constellation. Constellations were operated by several airlines, the most famous being TWA, and their pressurized cabins and long range made them popular with passengers.



In Flight with TWA . . .

TWA'S
Super-Constellation
SKYLINER

You enjoy luxury living aloft as you fly smoothly in TWA's dependable, giant new Super-Constellation Skyliners, the latest word in swift, modern passenger aircraft.

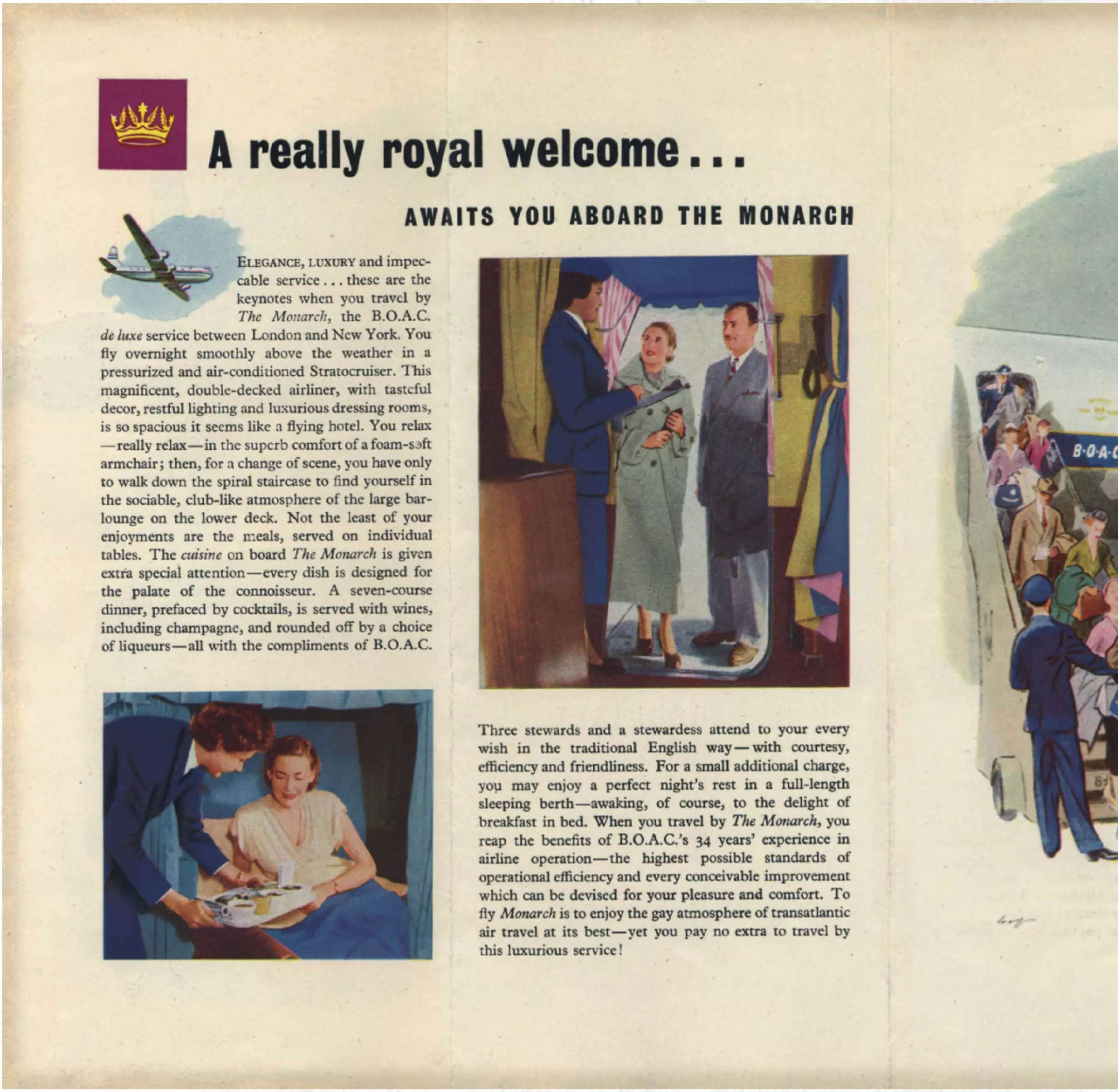
TWA
TRANS WORLD AIRLINES
U.S.A. · EUROPE
AFRICA · ASIA

Donald Douglas
(1892–1981)

Donald Douglas established the Douglas aircraft manufacturing company – one of the most prestigious names in aviation, responsible for some of the most successful aircraft ever built. He studied at the Massachusetts Institute of Technology, and then began his career at Martin aircraft before founding the Douglas Aircraft Company in 1921. Following the Second World War, he was responsible for creating the DC series of aircraft, including the legendary DC-3. After the war, Douglas continued to play a key role in the development of passenger flight, developing the DC-6 and DC-7.

OPPOSITE: A Douglas DC-7C of Dutch airline KLM. The DC-7, the final variant of the four piston-engine DC series, could carry just over 100 passengers at a cruising speed of 580 kilometres per hour (360 miles per hour).

BELOW: A BOAC steward serving a passenger on a Bristol Britannia in the mid 1950s. The promise of high-quality food and well-prepared meals was often used to entice customers, especially at a time when ticket prices were set by the IATA and cost could not be used to undercut the competition.

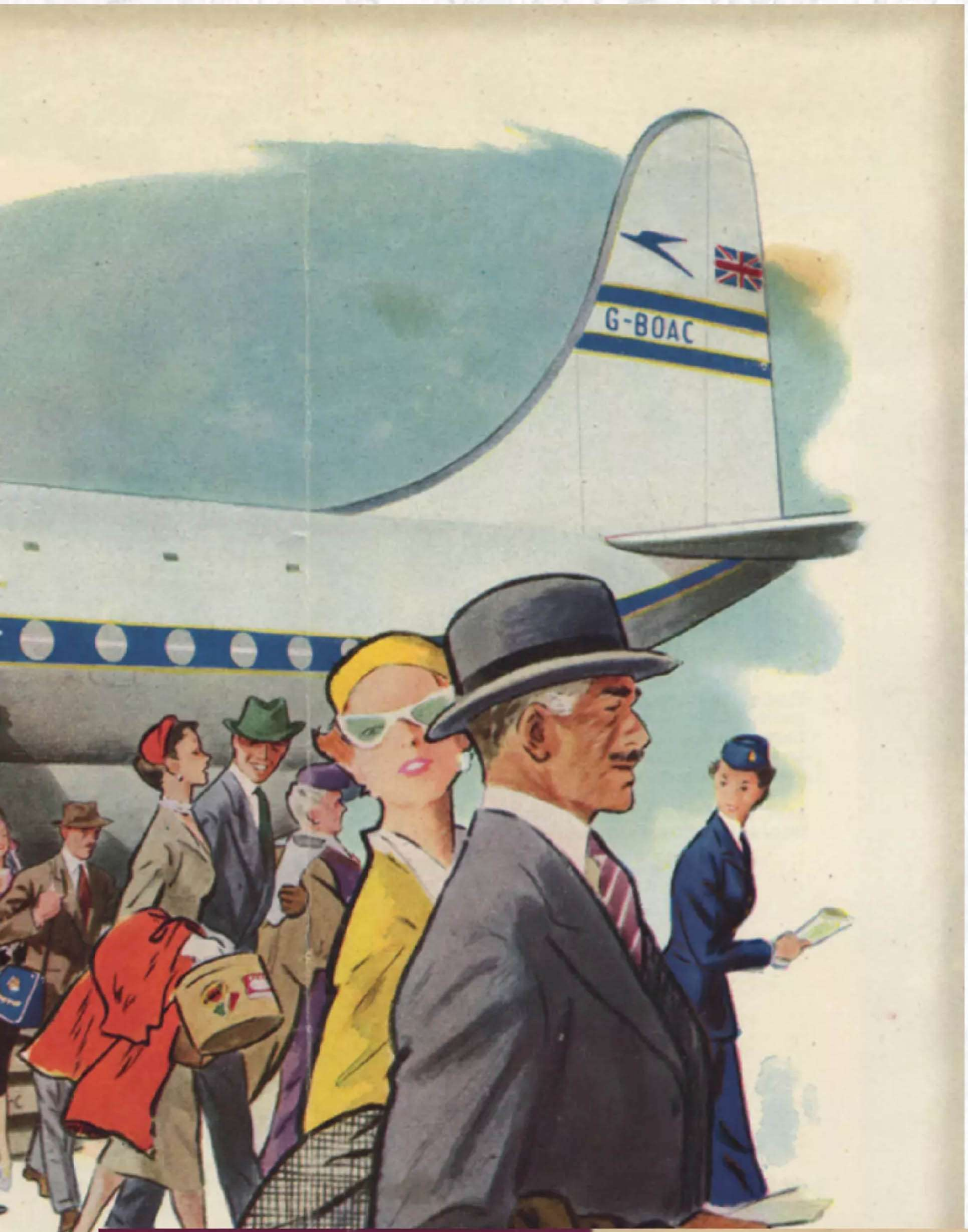


A really royal welcome . . .

AWAITS YOU ABOARD THE MONARCH

ELEGANCE, LUXURY and impeccable service . . . these are the keynotes when you travel by *The Monarch*, the B.O.A.C. *de luxe* service between London and New York. You fly overnight smoothly above the weather in a pressurized and air-conditioned Stratocruiser. This magnificent, double-decked airliner, with tasteful decor, restful lighting and luxurious dressing rooms, is so spacious it seems like a flying hotel. You relax—really relax—in the superb comfort of a foam-soft armchair; then, for a change of scene, you have only to walk down the spiral staircase to find yourself in the sociable, club-like atmosphere of the large bar-lounge on the lower deck. Not the least of your enjoyments are the meals, served on individual tables. The *cuisine* on board *The Monarch* is given extra special attention—every dish is designed for the palate of the connoisseur. A seven-course dinner, prefaced by cocktails, is served with wines, including champagne, and rounded off by a choice of liqueurs—all with the compliments of B.O.A.C.

Three stewards and a stewardess attend to your every wish in the traditional English way—with courtesy, efficiency and friendliness. For a small additional charge, you may enjoy a perfect night's rest in a full-length sleeping berth—awaking, of course, to the delight of breakfast in bed. When you travel by *The Monarch*, you reap the benefits of B.O.A.C.'s 34 years' experience in airline operation—the highest possible standards of operational efficiency and every conceivable improvement which can be devised for your pleasure and comfort. To fly *Monarch* is to enjoy the gay atmosphere of transatlantic air travel at its best—yet you pay no extra to travel by this luxurious service!

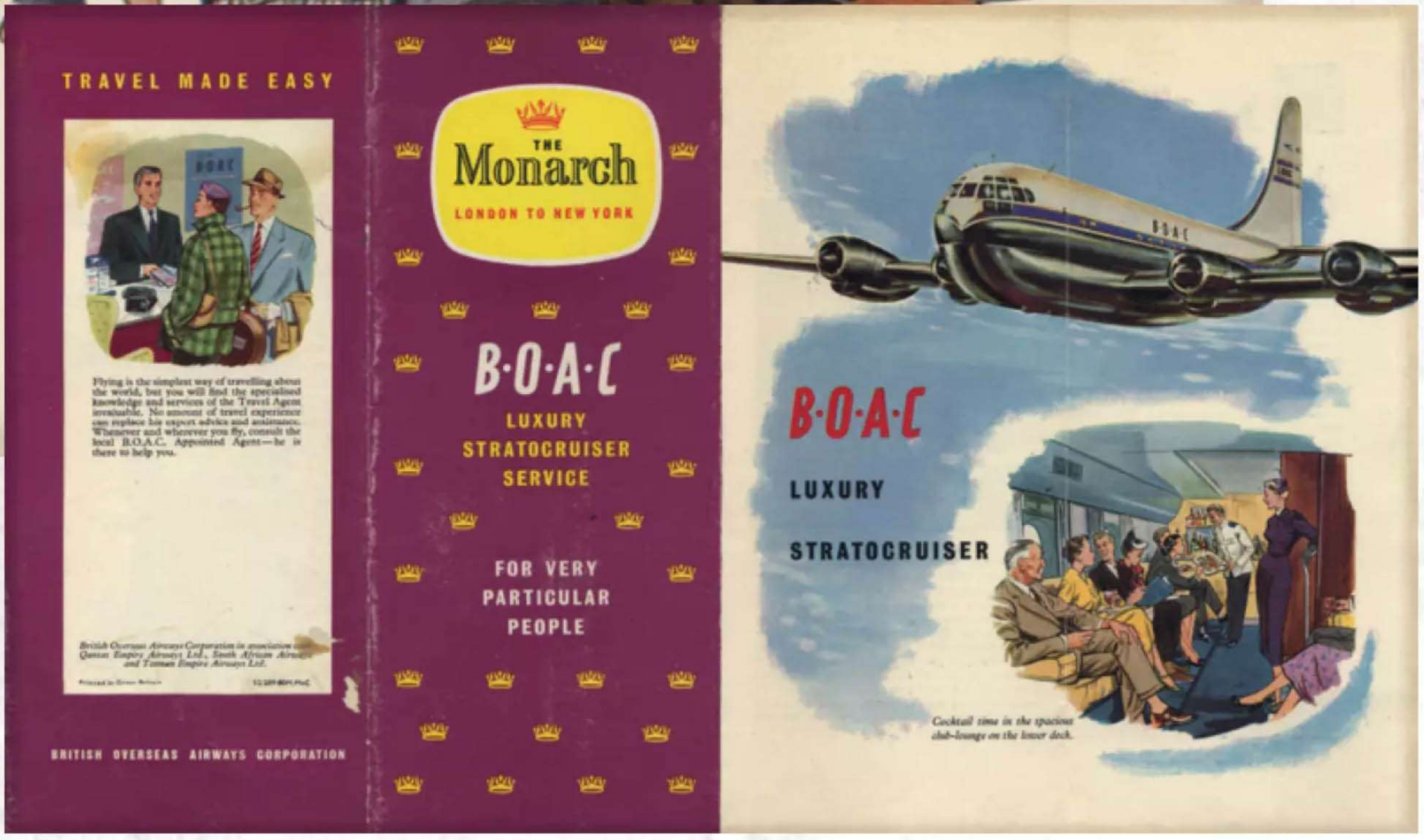


stood for Trans World Airlines, reflecting its enhanced global role) all lobbied the US government to win the right to conduct transatlantic flights to Europe.

The magnificent piston-engine aircraft that flew these routes were made by giant manufacturers who had been responsible for some of the finest combat aircraft of the Second World War – in particular Lockheed and McDonnell Douglas. The Lockheed Constellation – affectionately known as the "Connie" – is still widely regarded as a design classic, instantly recognizable with its triple tail. Matching the successive generations of Connies, Super Constellations and Starliners were the Douglas-built DC-6s and DC-7s, together with the Boeing Stratocruiser.

Although passenger travel was growing rapidly, it was by no means open to all. Prices were set high, barring most members of the public from enjoying the experience. Airlines sought to compete by offering still more luxurious services, with comfortable cabins and better food, replicating – and in many ways surpassing – the services offered in the age of the pre-war flying boats. Advances in engine technology and cabin pressurization meant that turbulence and poor weather could be more easily avoided, and journey times were considerably shortened. But, although in the 1950s piston-engine aircraft provided reliable flights across the oceans and the vast continent of the United States, there was a limit to how far the piston engine could be pushed.

Jet technology, which had been developed during the Second World War and used to power combat aircraft, was slow to be adapted to civil aviation. Jet engines were expensive to run and could not offer the same reliability as the tried-and-tested piston designs. Britain led the way in developing jet technology, first using it in a civil context with the turboprop – using the power of the jet engine to drive a propeller as well as the turbine. Turboprop airliners, such as the British Vickers Viscount, which entered airline service in 1950, bridged the gap between the piston engine and the jet age – when civil aviation truly began to open up for all.


TRAVEL MADE EASY

Flying is the simplest way of travelling about the world, but you will find the specialised knowledge and services of the Travel Agent invaluable. No amount of travel experience can replace his expert advice and assistance. Whenever and wherever you fly, consult the local B.O.A.C. Appointed Agent—he is there to help you.

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BRITISH OVERSEAS AIRWAYS CORPORATION

THE Monarch
LONDON TO NEW YORK

B·O·A·C
LUXURY
STRATOCRUISER
SERVICE

FOR VERY
PARTICULAR
PEOPLE

B·O·A·C
LUXURY
STRATOCRUISER

Cocktail time in the spacious club-lounge on the lower deck.

LEFT: A publicity leaflet produced by BOAC advertising their London–New York luxury "Monarch" passenger service. This was introduced in March 1951 using the Boeing Stratocruiser. Highlights included a seven-course meal, cocktails and sleeping berths.

COLD WAR CONFRONTATION

The dropping of atomic weapons on Japan in 1945 ushered in the nuclear age. The post-war confrontation between the Soviet Union and the West was based on the threat of Mutually Assured Destruction (the military doctrine that the side which launched a nuclear attack itself risked certain and total destruction in a counter-strike), and aircraft were at the forefront of the stand-off. Given the often vast distances involved, aircraft remained for many years the best way of delivering nuclear payloads. Airpower was vital in other ways too: U2 and SR-71 spy planes watched over enemy territory, and interceptor fighters stood poised to shoot the bombers down, while transports kept the beleaguered city of Berlin supplied in 1948 and 1949.

Berlin was an obvious flashpoint during the Cold War, situated deep in Soviet-controlled East Germany and itself divided between the victorious Allies. When the Soviet Union decided to block the land routes to the Western sector of the city, and so effectively starve the Western Allies out, the only way to keep Berlin alive was to supply it by air. Thus began the largest air supply operation ever mounted. Over a ten-month period, transports, mainly from the RAF and USAF, made around 277,000 flights. Half a decade earlier, many of the pilots had been delivering deadly cargoes of bombs to Berlin – now they brought food, coal and other essential supplies, which forced the Soviets to end the blockade in May 1949.

Throughout the 1950s, the focus for both sides was making sure that the nuclear deterrent was a realistic and effective one. Each side had to convince the other that it had the will to use, and the capability to deliver, nuclear weapons. For America in particular, this meant overseeing the production of vast fleets of bombers. In 1947, the USAF possessed just ten B-29s. Over the next ten years, a series of bombers were developed – including the Boeing B-47 and giant Convair B-36 – culminating in the B-52, one of the longest-serving aircraft ever built. In the United Kingdom, the nuclear deterrent was carried by the V-bombers – the Valiant, Victor and Vulcan. Soviet efforts produced the Tupolev Tu-95 in 1956, a turboprop-powered

OPPOSITE: A USAF C-54 Skymaster delivers its cargo to Berlin during the airlift. The C-54 was just one of the types that kept the city supplied. Others included USAF C-47 Skytrains and C-74 Globemasters, RAF Short Sunderlands, Avro Yorks and Handley Page Hastings.

Clarence "Kelly" Johnson

(1910–1990)

Johnson was one of the most innovative and creative aircraft designers in American history. He began working for Lockheed in 1933, and as the company's chief engineer designed several famous aircraft, including the P-38 Lightning and the Constellation passenger aeroplane. During the Second World War he developed the P-80 jet fighter, and the unit he assembled for that job – known as the "Skunk Works" after a 1940s comic strip – was a model of productive efficiency. The team applied their considerable talents to the development of the F-104 Starfighter, the U2 and SR-71 reconnaissance aircraft – all stalwarts of the Cold War.

Major Rudolf Anderson
(1927–1962)

Anderson was part of Strategic Air Command's 4080th Strategic Reconnaissance Wing, which provided key intelligence on the build up of Soviet missiles in Cuba. Anderson and Major Richard S Heyser made several flights over Cuba, bringing back photographs that helped President John F Kennedy to negotiate their removal with Soviet leader Nikita Krushchev. Then, on 27 October 1962, Anderson was killed when his aircraft was shot down by an SA-2 Surface-to-Air Missile. Anderson was the only American killed by enemy fire during the Cuban missile crisis.

bomber with a significantly greater range than its predecessors.

Intelligence gathering was a vital part of military strategy. The American company Lockheed produced two of the most iconic spy planes of the war – the U2 and the SR-71 Blackbird. Spy flights did not always go to plan – an international incident was caused when a U2 was shot down in 1960 over the Soviet Union and its pilot, Gary Powers, was captured. But the information the U2s provided was invaluable. Missions over Cuba obtained vital intelligence on the build-up of Soviet missiles during the Cuban missile crisis.

Defence against nuclear bombers was the job of interceptor fighters. Speed was the key here, and the aircraft designed in the 1950s to do this job were missile-carrying jet fighters with extremely powerful engines. Aircraft such as the American Convair F-106 and the British English Electric Lightning typified this approach to fighter production. In addition to fighter defence, Surface-to-Air Missiles (SAMs) formed a vital part of anti-aircraft systems on both sides. Indeed, some believed that the SAM would come to wholly replace the manned fighter, and they went on to prove very effective at shooting down high-level aircraft, such as spy planes.

Missiles were not employed just to bring down aircraft. From the early 1960s, when technology had overcome many of the disadvantages of unmanned systems, and the missiles became fitted with nuclear payloads, they began to replace the bomber. Both Intercontinental Ballistic Missiles (ICBMs) and submarine-launched systems such as Polaris had distinct advantages over bombers. Missile silos were easier to hide than airfields, and submarines found it easier still to remain undetected. Ballistic missiles were largely impervious to being shot down, either by fighters or missiles. And, perhaps most importantly, they were very much faster than bombers, shortening the time the enemy would have to launch a counter-strike before being annihilated by the overwhelming power of a nuclear attack.

LEFT: Test-firing a US LGM-30 Minuteman Intercontinental Ballistic Missile. The first Minuteman entered service in the early 1960s. The current variant, Minuteman III, is capable of traveling at 24,000 kilometres per hour (nearly 15,000 mile per hour), with a range of around 10,000 kilometres (6,200 miles).

Campaign for Nuclear Disarmament
HAMMERSMITH
S. AFRICA
ARCHITECTS'
GROUP
78
82
H-B
NUCLEAR
HIROSHIMA
— 1945
160,000

A large crowd of anti-nuclear weapons protesters from the CND (Campaign for Nuclear Disarmament) in Trafalgar Square, London, 1959. The overwhelming destructive power of nuclear weapons led many people to join disarmament groups. In the UK, protests were often held against the nuclear weapons – first bombs, then missiles – based in Britain as part of the country's commitment to NATO.

GLORIOUS Seafish
Guinness for Strength
Combined Universities Campaign
YOUTH CAMPAIGN FOR NUCLEAR DISARMAMENT
ALDERMASTON–LONDON
EASTER 1959
YOUTH FOR PEACE
WANTS
LIFE
ST IVES CORNWALL
TOTTENHAM GROUP
UGANDA BRITAIN
BAN H-BOMBS
NO AMERICAN BASES ON
BRITISH SOIL
86
STOKE

AIR POWER IN KOREA AND VIETNAM

Half a decade after the end of the Second World War and less than a year after the Berlin Airlift, East and West again clashed when Communist North Korea invaded its southern neighbour in 1950. Barely a decade after that, the United States was again at war in Asia, this time attempting to prevent a Communist takeover of South Vietnam. Although these conflicts were brutal and protracted, both stopped short of all-out nuclear war. Rather than delivering knock-out strategic nuclear blows, aircraft in Korea and Vietnam carried out the same jobs that they had undertaken in the First and Second World Wars: conventional bombing, fighting for superiority in the air over the battlefield and, most importantly, supporting soldiers on the ground.

Aircraft immediately proved their worth in the earliest phases of the Korean War, halting and repelling the Communist advance through tactical bombing. The aircraft that carried out these ground-attack missions were mainly older types dating back to the Second World War, such as the American B-29 Superfortress and P-51 Mustang. These machines again proved how aircraft could be used to alter the course of a battle. When China entered the conflict, with its high-performance MiG-15 fighters, US aerial dominance over the battlefield was put in jeopardy. The USAF then introduced its own next-generation aircraft – notably the F-86 Sabre – which meant that for the first time, jets fought jets.

The role of the aircraft as military transport was dramatically demonstrated in Korea, particularly in the early stage of the conflict, which was characterized by rapid advance and equally rapid withdrawal. Cargo aircraft delivered supplies and airlifted troops, as well as providing a vital air bridge with US bases in Japan. And for the first time helicopters played a significant part in a campaign, particularly in the transport role, and especially in evacuating casualties.

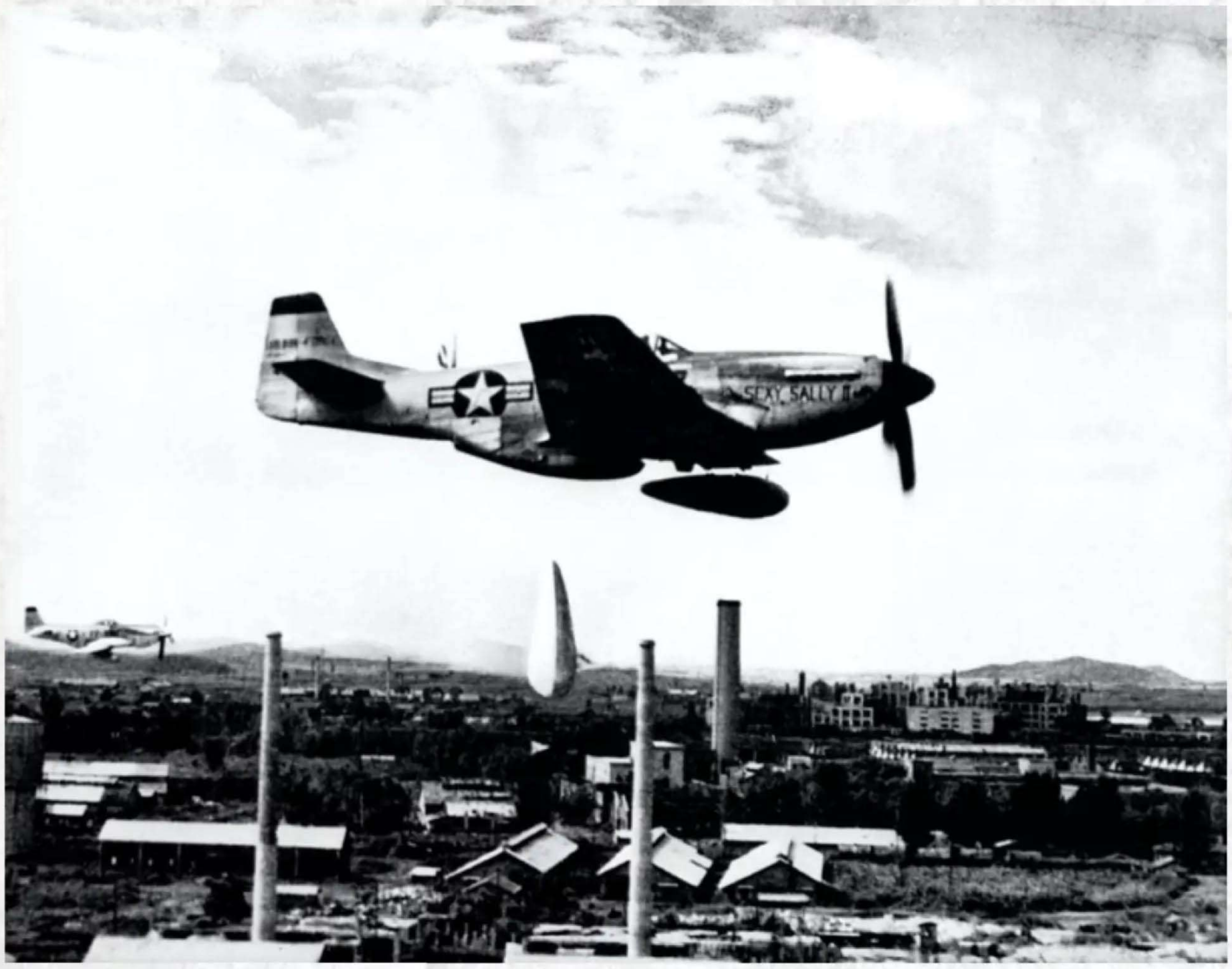
By the mid 1960s, America had become involved in another "hot war" against communism, this time in Vietnam. The USAF was the most powerful air force in the world, yet in a decade of fighting, it was unable to translate that overwhelming might into victory on the battlefield. In March 1965, Operation "Rolling Thunder" was launched, a bombing campaign targeted against North Vietnam. It was hoped that this would force the Communists to give up, but it proved unsuccessful. Similar campaigns later in the war were similarly unsuccessful. The detailed rules of engagement that forced the USAF to avoid many targets and the resilience of the enemy were just two of the reasons that prevented the bomber having a decisive impact on the war.

Helicopters – epitomized by the Bell UH-1 Huey – were the true workhorses of the Vietnam War, expanding upon the role that they fulfilled in Korea. They ferried troops into action, evacuated casualties and undertook ground-attack missions with rockets and machine guns. Close air support was also provided by fixed-wing aircraft such as the piston-engined A-1 Skyraider and the jet F-4 Phantom. The fighters did not enjoy the same degree of success in aerial combat as they had in Korea, partly because of the strict rules of engagement – US pilots had to have visual confirmation of enemy aircraft, negating any advantage they may have had from their air-to-air missiles.

RIGHT: The North American F-86 Sabre. The battles that took place between the USAF F-86s and the Communist MiG-15s were fought using machine guns and cannons, and the tactics used were similar to those employed in the Second World War. The crucial difference was that the faster speed at which the jet fighters flew meant that more airspace was needed for dogfights.

AIR FORCE

466
394



Air power did not win the Vietnam War. Whether fighting against US jet fighters or helicopter-borne "aerial cavalry", the enemy found ways to avoid combat on anything but the most favourable terms. Ultimately, the most significant advances to come out the conflict were technological, not tactical or strategic. These included "smart" weapons, electronic warfare and advanced anti-aircraft systems, all of which would be refined and used in later conflicts.

OPPOSITE: Men of the United States 1st Air Cavalry about to board their helicopter. The US "airmobile" tactics were designed to cope with the varied terrain of Vietnam and the elusiveness of the enemy forces. Troops could be quickly moved into battle and supported from the air.

LEFT: A USAF P-51 Mustang releasing napalm over North Korea in 1951. The piston engine P-51 was a Second World War design that proved to be very successful in the ground-attack role. However, piston-engine fighters could not hope to match the air-to-air combat ability of the jet fighters which began to be used as the war progressed.

Lieutenant-Colonel Vermont Garrison

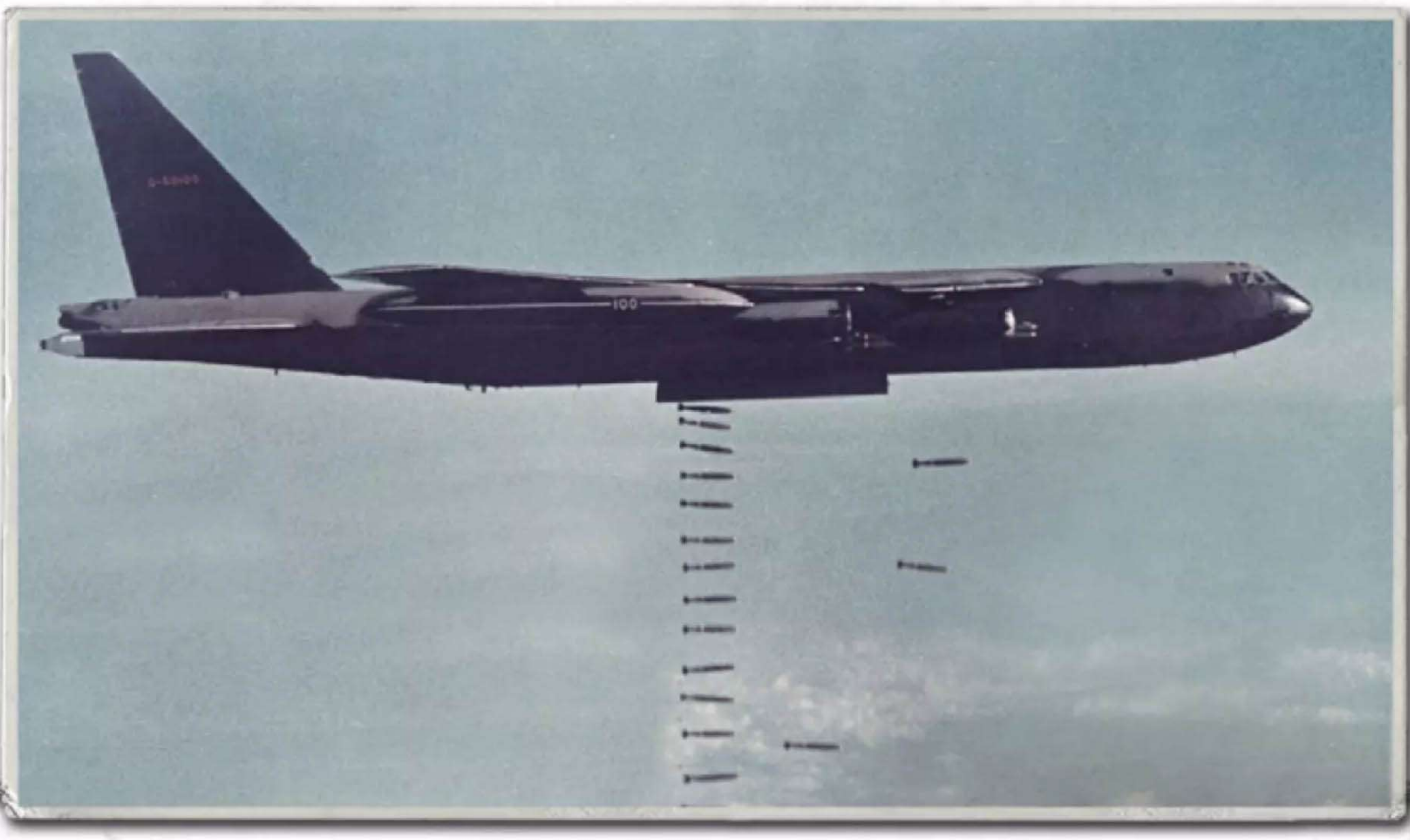
(1915–1994)

Vermont Garrison was the oldest of the Korean War "aces", eventually shooting down 10 MiGs. Like many of the Korean War pilots, Garrison was also a very successful Second World War fighter pilot. The "aces" of the Korean War attracted much public attention. Competition was fierce between the Sabre pilots to record the most "kills", just as it had been in previous conflicts, particularly in the First World War. The Sabres were often outnumbered by the MiGs, who also fought much closer to their bases. But the USAF pilots were better trained and crucially much more experienced.

Boeing B-52 Stratofortress

The B-52 was the ultimate Cold War weapon, designed to deliver nuclear bombs on to Soviet cities. So successful was the design that B-52s remain in service today, and for the foreseeable future. The B-52 was dramatically re-purposed during the Vietnam War, being used to drop 225- or 340-kilogram- (500- or 750-pound-) bombs on tactical targets such as enemy supply routes or camps, or in support of ground forces. The use of such overwhelming force (essentially carpet-bombing) was justified at the time because of the difficulty in spotting pinpoint targets in the dense jungle. But after the war, the proportionality of the raids was questioned, given the huge tonnage of bombs dropped for little real gain.

BELOW: A USAF Boeing B-52 drops its bombs. Despite being developed as a strategic bomber, during the Vietnam War B-52s were often used to carpet-bomb areas of jungle in order to knock out supply routes, troops and camps. In the process they destroyed several square kilometres of jungle or rice paddy field at a time.



2
NG
USS ENTERPRISE
2283
VF-96
NAVY
202

A US Navy F4-B Phantom attacks a Viet Cong position. Ground troops would often call on aircraft to provide close air support against well-concealed guerrilla forces.

602

THE SPACE RACE

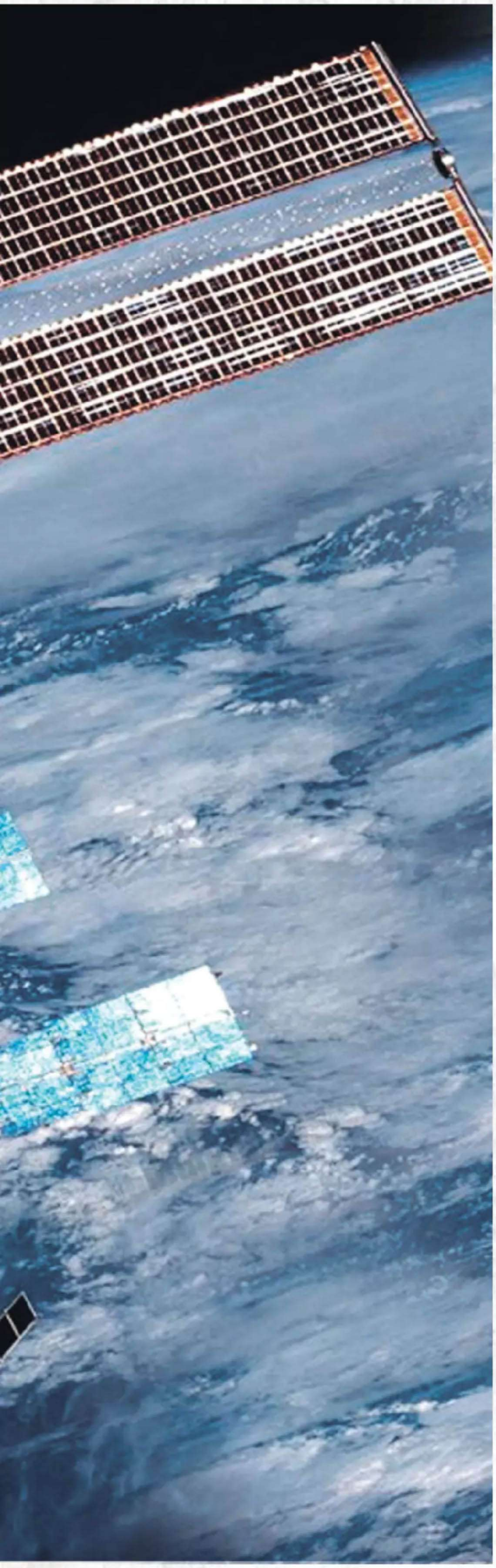
Space flight in the 1960s was made possible thanks to technological advances during the Second World War, while the enormous developments that were required to send people first into orbit, and then to the Moon, would not have happened as rapidly without the near-fatal clash of ideologies that formed the Cold War.

It had been considered that only the explosive power of the rocket engine could reliably overcome the Earth's gravity. In the 1930s, it was Germany that led the field in this research. The Nazi regime invested a great deal of money and effort into developing rockets as weapons, culminating in the creation of the V2. This was designed by the best German scientists available led by the brilliant Wernher von Braun, and built by slave labour and prisoners of war.

As they advanced across Germany, the Americans and Soviets rushed to secure the expertise of the engineers responsible for the V2s. Von Braun and over 100 of his colleagues were spirited away to the United States.

OPPOSITE: The Saturn V rocket designed to launch the Apollo missions to the moon. 15 Saturn Vs were built. They were over 100 metres (330 feet) tall and propelled by a combination of kerosene, liquid oxygen and liquid nitrogen, powering a total of 11 engines: five in the first stage, five in the second and one in the third.

BELOW: The seven astronauts selected for Project Mercury were all highly skilled military test-pilots who met very stringent standards of physical fitness. The Mercury astronauts were Alan Shephard, M Scott Carpenter, John Glenn, Donald "Deke" Slayton, Virgil "Gus" Grissom, Wally Schirra and L Gordon Cooper.



Others – mainly lower ranking scientists than those in von Braun's team – ended up in Russia, enhancing a rocket programme that had been second only to Germany's in the 1920s and 1930s. By the 1950s, under the gifted Sergei Korolev, the Soviet Union had already developed rockets that could generate more than twice as much thrust as their American counterparts.

The Soviets achieved the first significant advances with the launch of their Sputnik satellite in October 1957. They made a great show of their successes, which in turn fuelled America's desire not to be seen as technologically inferior to the Communists. The US responded with the launch of the satellite Explorer I in January 1958. What subsequently became known as the "Space Race" had begun in earnest.

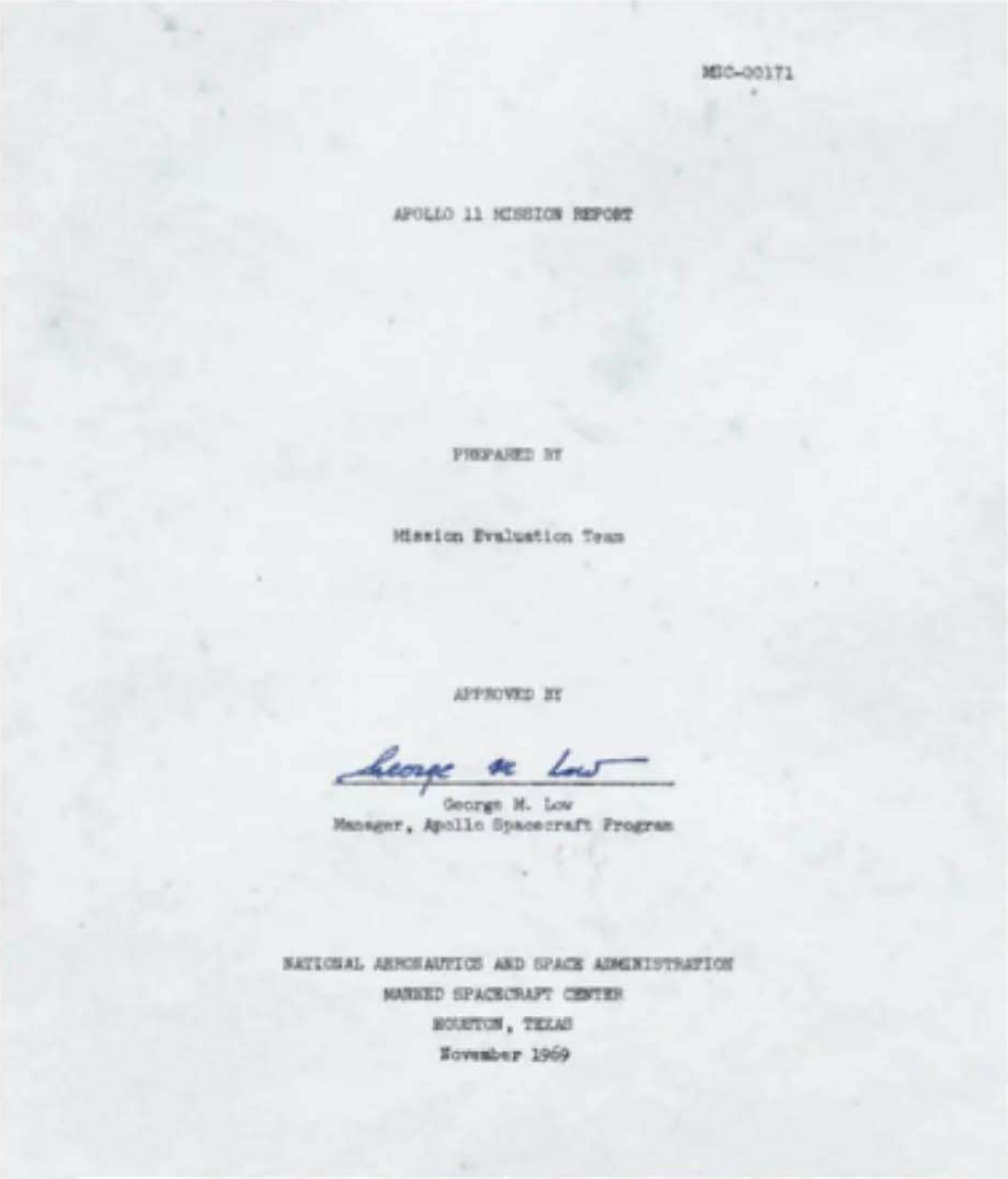
Next on the list of notable firsts was manned space flight. Again, the Soviet Union beat the American efforts by launching "Cosmonaut" Yuri Gagarin on an orbital flight in April 1961. "Astronaut" Alan Shephard became the first American in space in May of the same year, and later the same month President Kennedy announced that it would be the goal of the United States to put a man on the Moon and return him safely to Earth by the end of the decade. Determined to maintain their lead, the Soviets also attempted to reach the prize. The American National Aeronautics and Space Administration (NASA) worked methodically through the considerable problems of directing a crew to a target 400,000 kilometres (250,000 miles) away. Astronauts were launched on ever more advanced and demanding missions that culminated in July 1969 with Apollo 11, which landed Neil Armstrong and Edwin "Buzz" Aldrin on the Moon.

Both the American public and politicians began to lose interest in the Apollo programme after the first few missions, and

LEFT: The International Space Station. Many nations have contributed elements to the project, principally the United States and Russia. It consists of several distinct modules, each fulfilling a different function. These include crew quarters and laboratory facilities. Components are carried into orbit by shuttles or rockets.

Werner von Braun
(1912–1977)

Von Braun was the most important scientist in the German pre-war investigations into rocketry. He maintained after the war that his work on weapons was a means to an end, and that his real interest and passion was for manned space travel. At the end of the war he was determined to offer his services to the Americans, rather than the Soviets, and he became the leading figure in the development of American rockets – both the deadly ICBMs and the more benign space vehicles.



MSC-00171

APOLLO 11 MISSION REPORT

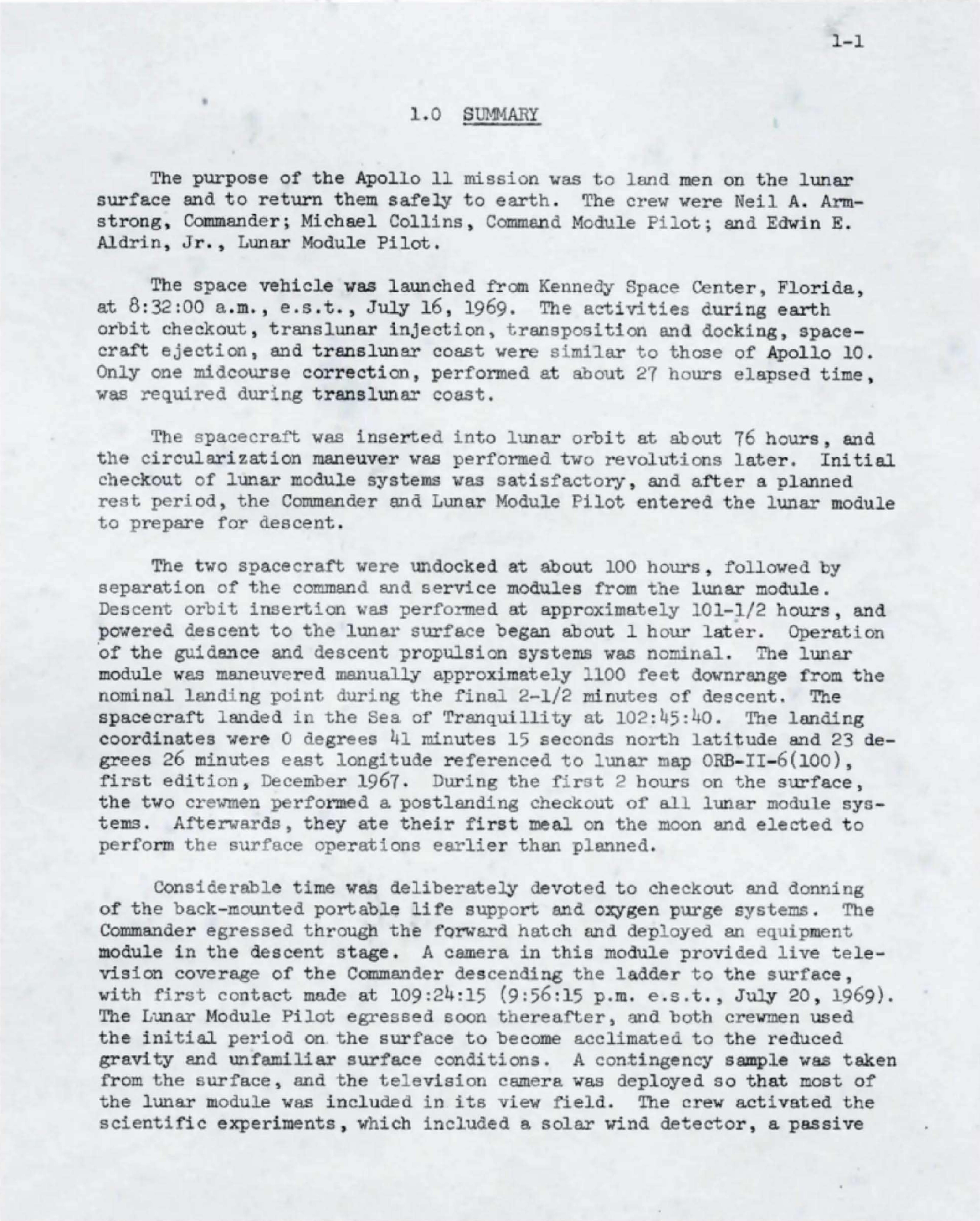
PREPARED BY

Mission Evaluation Team

APPROVED BY

George M Low
George M. Low
Manager, Apollo Spacecraft Program

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
November 1969



1.0 SUMMARY

The purpose of the Apollo 11 mission was to land men on the lunar surface and to return them safely to earth. The crew were Neil A. Armstrong, Commander; Michael Collins, Command Module Pilot; and Edwin E. Aldrin, Jr., Lunar Module Pilot.

The space vehicle was launched from Kennedy Space Center, Florida, at 8:32:00 a.m., e.s.t., July 16, 1969. The activities during earth orbit checkout, translunar injection, transposition and docking, spacecraft ejection, and translunar coast were similar to those of Apollo 10. Only one midcourse correction, performed at about 27 hours elapsed time, was required during translunar coast.

The spacecraft was inserted into lunar orbit at about 76 hours, and the circularization maneuver was performed two revolutions later. Initial checkout of lunar module systems was satisfactory, and after a planned rest period, the Commander and Lunar Module Pilot entered the lunar module to prepare for descent.

The two spacecraft were undocked at about 100 hours, followed by separation of the command and service modules from the lunar module. Descent orbit insertion was performed at approximately 101-1/2 hours, and powered descent to the lunar surface began about 1 hour later. Operation of the guidance and descent propulsion systems was nominal. The lunar module was maneuvered manually approximately 1100 feet downrange from the nominal landing point during the final 2-1/2 minutes of descent. The spacecraft landed in the Sea of Tranquillity at 102:45:40. The landing coordinates were 0 degrees 41 minutes 15 seconds north latitude and 23 degrees 26 minutes east longitude referenced to lunar map ORB-II-6(100), first edition, December 1967. During the first 2 hours on the surface, the two crewmen performed a postlanding checkout of all lunar module systems. Afterwards, they ate their first meal on the moon and elected to perform the surface operations earlier than planned.

Considerable time was deliberately devoted to checkout and donning of the back-mounted portable life support and oxygen purge systems. The Commander egressed through the forward hatch and deployed an equipment module in the descent stage. A camera in this module provided live television coverage of the Commander descending the ladder to the surface, with first contact made at 109:24:15 (9:56:15 p.m. e.s.t., July 20, 1969). The Lunar Module Pilot egressed soon thereafter, and both crewmen used the initial period on the surface to become acclimated to the reduced gravity and unfamiliar surface conditions. A contingency sample was taken from the surface, and the television camera was deployed so that most of the lunar module was included in its view field. The crew activated the scientific experiments, which included a solar wind detector, a passive

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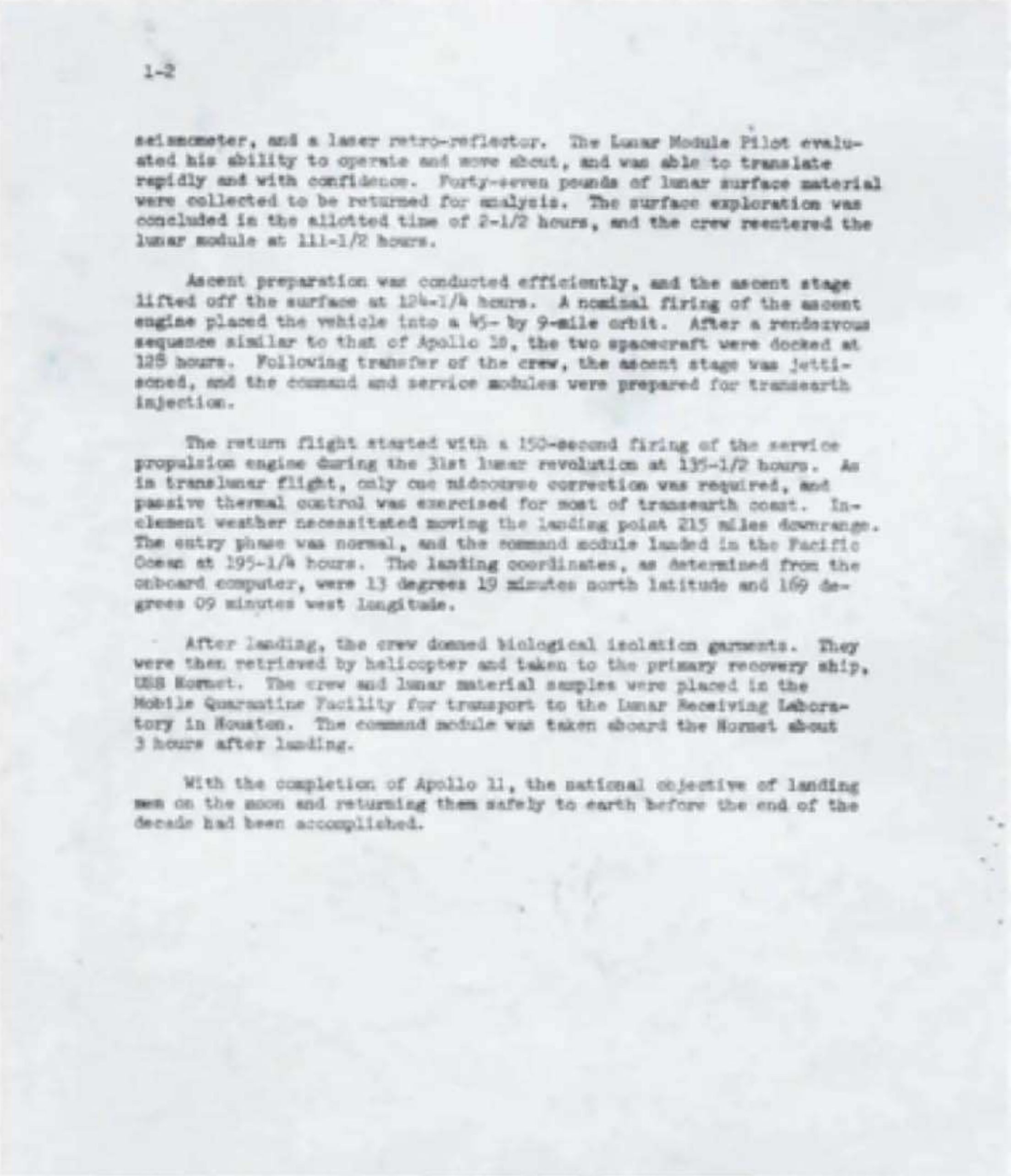


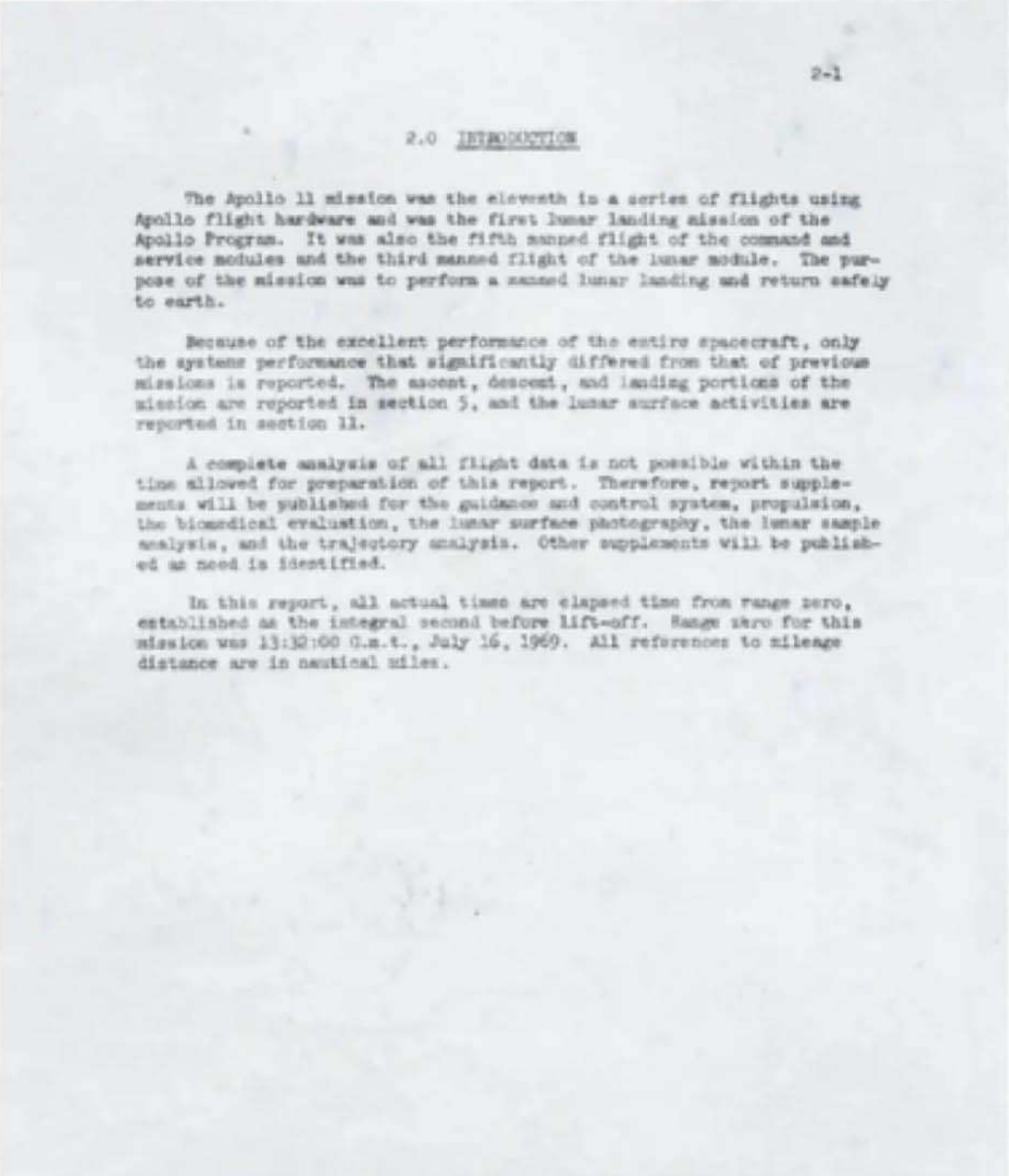
seismometer, and a laser retro-reflector. The Lunar Module Pilot evaluated his ability to operate and move about, and was able to translate rapidly and with confidence. Forty-seven pounds of lunar surface material were collected to be returned for analysis. The surface exploration was concluded in the allotted time of 2-1/2 hours, and the crew reentered the lunar module at 111-1/2 hours.

Ascent preparation was conducted efficiently, and the ascent stage lifted off the surface at 124-1/4 hours. A nominal firing of the ascent engine placed the vehicle into a 45- by 9-mile orbit. After a rendezvous sequence similar to that of Apollo 10, the two spacecraft were docked at 128 hours. Following transfer of the crew, the ascent stage was jettisoned, and the command and service modules were prepared for transearth injection.

The return flight started with a 150-second firing of the service propulsion engine during the 31st lunar revolution at 135-1/2 hours. As in translunar flight, only one midcourse correction was required, and passive thermal control was exercised for most of transearth coast. Inclement weather necessitated moving the landing point 215 miles downrange. The entry phase was normal, and the command module landed in the Pacific Ocean at 195-1/4 hours. The landing coordinates, as determined from the onboard computer, were 13 degrees 19 minutes north latitude and 169 degrees 09 minutes west longitude.

After landing, the crew donned biological isolation garments. They were then retrieved by helicopter and taken to the primary recovery ship, USS Hornet. The crew and lunar material samples were placed in the Mobile Quarantine Facility for transport to the Lunar Receiving Laboratory in Houston. The command module was taken aboard the Hornet about 3 hours after landing.

With the completion of Apollo 11, the national objective of landing men on the moon and returning them safely to earth before the end of the decade had been accomplished.



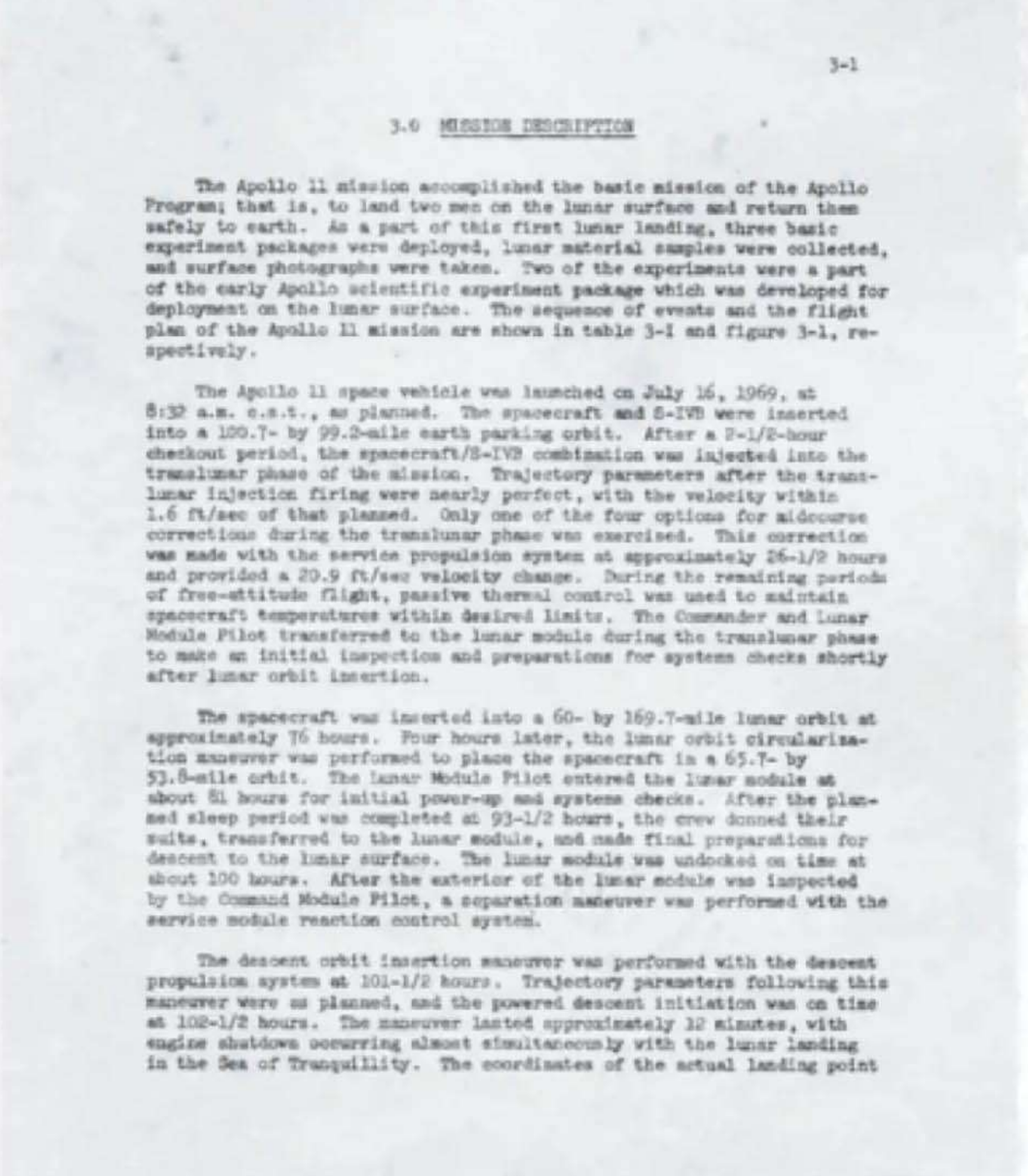
2.0 INTRODUCTION

The Apollo 11 mission was the eleventh in a series of flights using Apollo flight hardware and was the first lunar landing mission of the Apollo Program. It was also the fifth manned flight of the command and service modules and the third manned flight of the lunar module. The purpose of the mission was to perform a manned lunar landing and return safely to earth.

Because of the excellent performance of the entire spacecraft, only the systems performance that significantly differed from that of previous missions is reported. The ascent, descent, and landing portions of the mission are reported in section 5, and the lunar surface activities are reported in section 11.

A complete analysis of all flight data is not possible within the time allowed for preparation of this report. Therefore, report supplements will be published for the guidance and control system, propulsion, the biomedical evaluation, the lunar surface photography, the lunar sample analysis, and the trajectory analysis. Other supplements will be published as need is identified.

In this report, all actual times are elapsed time from range zero, established as the integral second before lift-off. Range zero for this mission was 13:32:00 G.m.t., July 16, 1969. All references to mileage distance are in nautical miles.



3.0 MISSION DESCRIPTION

The Apollo 11 mission accomplished the basic mission of the Apollo Program; that is, to land two men on the lunar surface and return them safely to earth. As a part of this first lunar landing, three basic experiment packages were deployed, lunar material samples were collected, and surface photographs were taken. Two of the experiments were a part of the early Apollo scientific experiment package which was developed for deployment on the lunar surface. The sequence of events and the flight plan of the Apollo 11 mission are shown in table 3-I and figure 3-1, respectively.

The Apollo 11 space vehicle was launched on July 16, 1969, at 8:32 a.m. e.s.t., as planned. The spacecraft and S-IVB were inserted into a 100.7- by 99.2-mile earth parking orbit. After a 2-1/2-hour checkout period, the spacecraft/S-IVB combination was injected into the translunar phase of the mission. Trajectory parameters after the translunar injection firing were nearly perfect, with the velocity within 1.6 ft/sec of that planned. Only one of the four options for midcourse corrections during the translunar phase was exercised. This correction was made with the service propulsion system at approximately 26-1/2 hours and provided a 20.9 ft/sec velocity change. During the remaining periods of free-attitude flight, passive thermal control was used to maintain spacecraft temperatures within desired limits. The Commander and Lunar Module Pilot transferred to the lunar module during the translunar phase to make an initial inspection and preparations for systems checks shortly after lunar orbit insertion.

The spacecraft was inserted into a 60- by 169.7-mile lunar orbit at approximately 76 hours. Four hours later, the lunar orbit circularization maneuver was performed to place the spacecraft in a 65.7- by 53.8-mile orbit. The Lunar Module Pilot entered the lunar module at about 81 hours for initial power-up and systems checks. After the planned sleep period was completed at 93-1/2 hours, the crew donned their suits, transferred to the lunar module, and made final preparations for descent to the lunar surface. The lunar module was undocked on time at about 100 hours. After the exterior of the lunar module was inspected by the Command Module Pilot, a separation maneuver was performed with the service module reaction control system.

The descent orbit insertion maneuver was performed with the descent propulsion system at 101-1/2 hours. Trajectory parameters following this maneuver were as planned, and the powered descent initiation was on time at 102-1/2 hours. The maneuver lasted approximately 12 minutes, with engine shutdown occurring almost simultaneously with the lunar landing in the Sea of Tranquillity. The coordinates of the actual landing point

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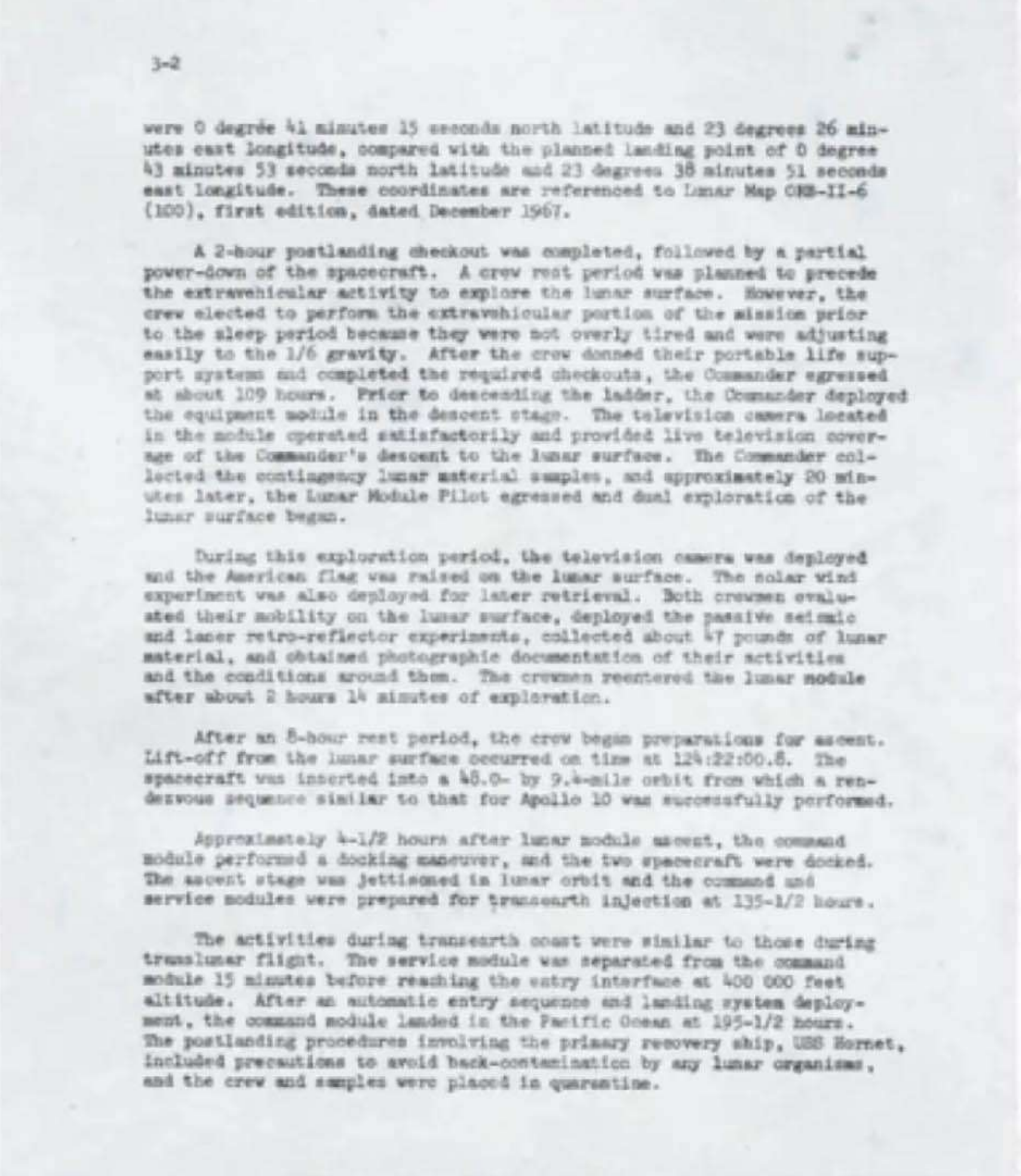


were 0 degree 41 minutes 15 seconds north latitude and 23 degrees 26 minutes east longitude, compared with the planned landing point of 0 degree 43 minutes 53 seconds north latitude and 23 degrees 38 minutes 51 seconds east longitude. These coordinates are referenced to Lunar Map ORB-II-6 (100), first edition, dated December 1967.

A 2-hour postlanding checkout was completed, followed by a partial power-down of the spacecraft. A crew rest period was planned to precede the extravehicular activity to explore the lunar surface. However, the crew elected to perform the extravehicular portion of the mission prior to the sleep period because they were not overly tired and were adjusting easily to the 1/6 gravity. After the crew donned their portable life support systems and completed the required checkouts, the Commander egressed at about 109 hours. Prior to descending the ladder, the Commander deployed the equipment module in the descent stage. The television camera located in the module operated satisfactorily and provided live television coverage of the Commander's descent to the lunar surface. The Commander collected the contingency lunar material samples, and approximately 20 minutes later, the Lunar Module Pilot egressed and dual exploration of the lunar surface began.

During this exploration period, the television camera was deployed and the American flag was raised on the lunar surface. The solar wind experiment was also deployed for later retrieval. Both crewmen evaluated their mobility on the lunar surface, deployed the passive seismic and laser retro-reflector experiments, collected about 47 pounds of lunar material, and obtained photographic documentation of their activities and the conditions around them. The crewmen reentered the lunar module after about 2 hours 14 minutes of exploration.

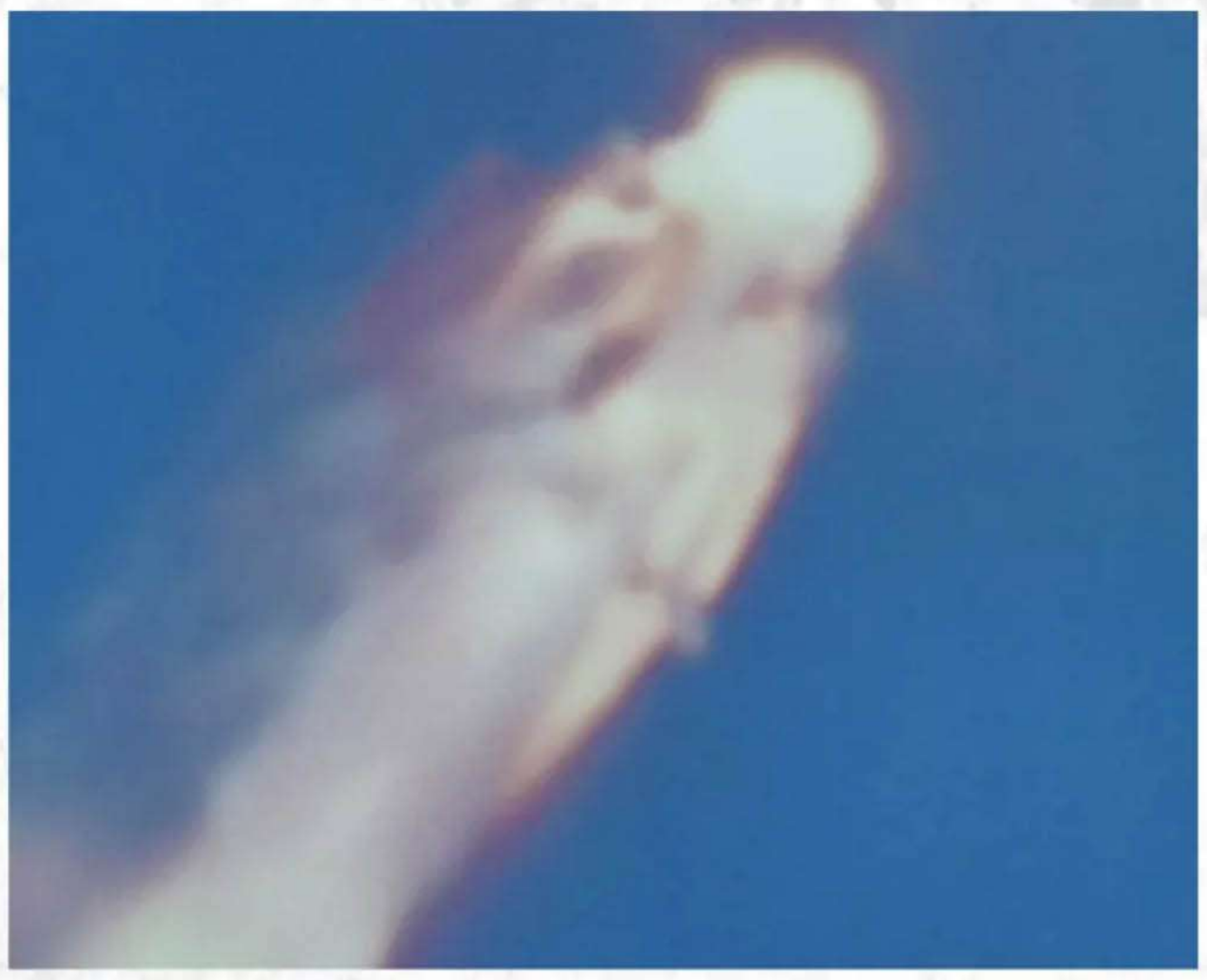
After an 8-hour rest period, the crew began preparations for ascent. Lift-off from the lunar surface occurred on time at 124:22:00.8. The spacecraft was inserted into a 48.0- by 9.4-mile orbit from which a rendezvous sequence similar to that for Apollo 10 was successfully performed.

Approximately 4-1/2 hours after lunar module ascent, the command module performed a docking maneuver, and the two spacecraft were docked. The ascent stage was jettisoned in lunar orbit and the command and service modules were prepared for transearth injection at 135-1/2 hours.

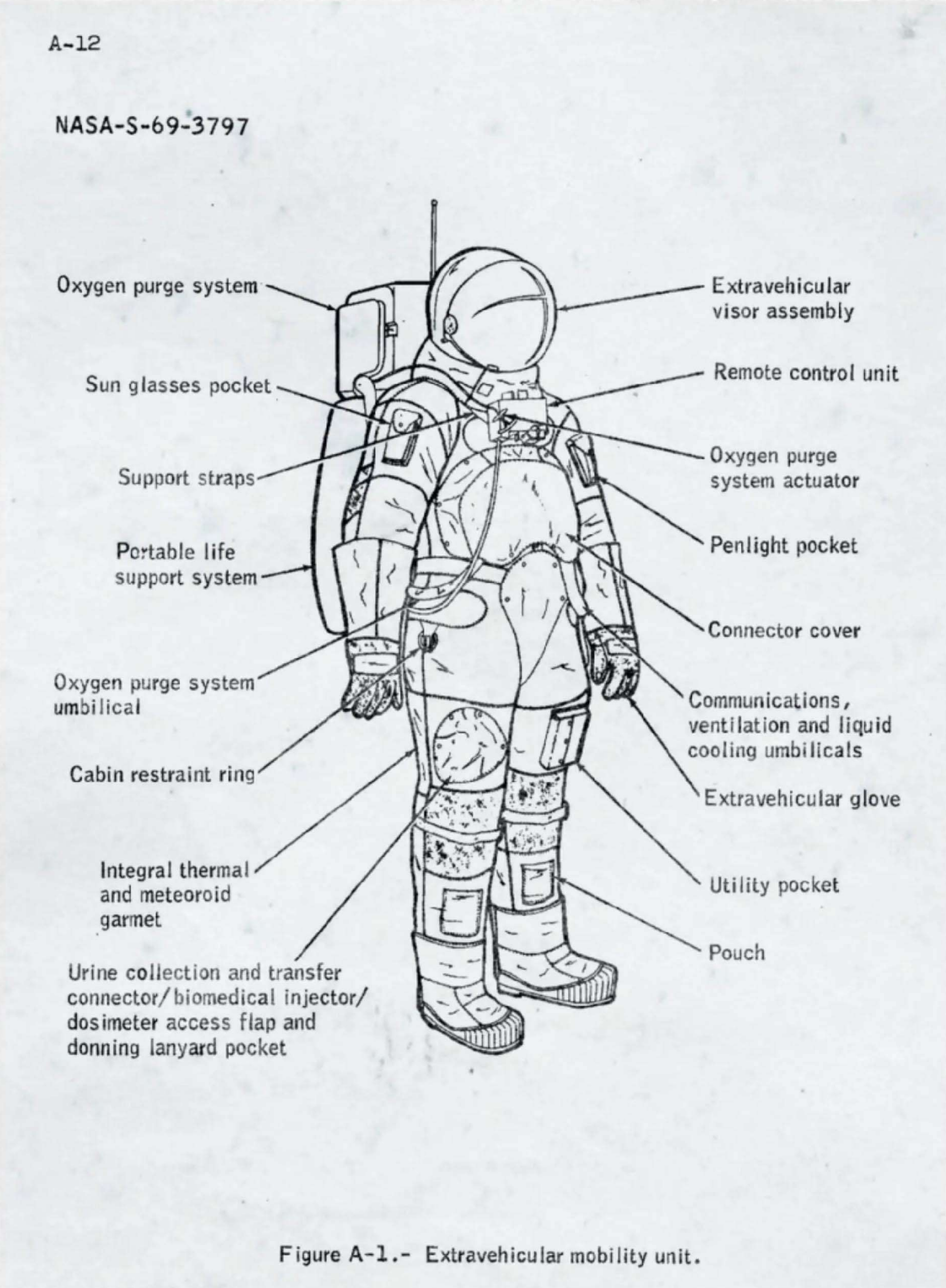
The activities during transearth coast were similar to those during translunar flight. The service module was separated from the command module 15 minutes before reaching the entry interface at 400 000 feet altitude. After an automatic entry sequence and landing system deployment, the command module landed in the Pacific Ocean at 195-1/2 hours. The postlanding procedures involving the primary recovery ship, USS Hornet, included precautions to avoid back-contamination by any lunar organisms, and the crew and samples were placed in quarantine.

on 14 December 1972 astronaut Gene Cernan became the last person to walk on the Moon. The Soviet space programme had by now already shifted to the potential for scientific study afforded by building space stations in orbit around the Earth – developing their technology with the Salyut programme, followed by the famous Mir. America launched Skylab in 1973. New levels of international co-operation were achieved by beginning the construction of the International Space Station in 1998.

While the Soviets continued to focus on rockets to launch their cosmonauts, NASA turned its attention to reusable systems which would, it was hoped, reduce the crippling level of expenditure associated with the space programme. The result was the Space Shuttle, which regrettably was not as economical as had been forecast. Intended to make space travel more routine, the programme is unfortunately remembered by many for the tragic loss of the shuttles Challenger in 1986 and Columbia in 2003. Meanwhile, in a bid to find more money for their programme, Russia began to open up space travel to the super rich.



ABOVE: The space shuttle Challenger, which exploded on 28 January 1986 with the loss of all seven crew. This dealt a severe blow to the US space programme, and shuttles did not fly again until September 1988. Seven further shuttle astronauts were lost in 2003 when Columbia broke up as it returned to Earth, leaving three shuttles – Discovery, Endeavour and Atlantis – of the original five.



A-12

NASA-S-69-3797

Oxygen purge system
Sun glasses pocket
Support straps
Portable life support system
Oxygen purge system umbilical
Cabin restraint ring
Integral thermal and meteoroid garmet
Urine collection and transfer connector/ biomedical injector/ dosimeter access flap and donning lanyard pocket
Extravehicular visor assembly
Remote control unit
Oxygen purge system actuator
Penlight pocket
Connector cover
Communications, ventilation and liquid cooling umbilicals
Extravehicular glove
Utility pocket
Pouch

Figure A-1.- Extravehicular mobility unit.

LEFT AND OPPOSITE: The Apollo 11 mission report. In understated detail, it describes the mission undertaken by the three-man crew, Neil Armstrong, Edwin "Buzz" Aldrin and Michael Collins. Their goal was simply summarized as "perform a manned lunar landing and return safely to Earth".

Sergei Korolev
(1906–1966)

Korolev was a qualified aeronautical engineer who was a founder member of the Moscow Group for Study of Reaction Motion in the 1930s. He led the Soviet Union's pre-war rocket research, but was arrested in 1938 as part of a Stalinist purge, charged with treason and sent to the Gulag. He was saved by being recalled to work in the Russian aircraft industry, and released in 1944. He then led the development of Soviet rockets, presiding over the most successful period in the space programme, beating the United States to several "firsts".

THE JET AGE

The jet engine revolutionized air transport. In the space of three decades, flying went from an elite form of travel to an everyday occurrence familiar to millions. Britain took the lead in jet-powered passenger aircraft with the de Havilland Comet, which entered service in 1952. The wealthy passengers that made up the majority of airline customers loved its speed, comfort and style. However, the Comet's promising career was effectively destroyed by three tragic crashes. The type was grounded while investigators discovered the problem (metal fatigue exacerbated by the aircraft's rectangular windows), and by the time the redesigned Comet 4 entered service, other companies had followed de Havilland's example and entered the jet airliner market.

This was particularly true in the United States, where Boeing led the field. In 1958, they introduced the 707, which could carry more than double the number of passengers of the re-introduced Comet 4. They were hugely popular and the Douglas Aircraft Company attempted to match Boeing's success with the larger DC-8. Although these models both served in large numbers, 707s outsold DC-8s, firmly placing Boeing in front. As technology improved and jets became more efficient and reliable, they even began to replace turboprop airliners on shorter journeys. A notable aircraft in this class was the French Sud Aviation Caravelle, a medium range jet airliner that was introduced on US internal routes.

OPPOSITE: Female flight attendants, popularly known as air hostesses (seen here in front of a de Havilland Comet), were a key part of the marketing campaigns of many airlines, particularly during the 1960s and 1970s.

BELOW: Boeing 707s at the Boeing plant in Renton Washington, 1958. Although the de Havilland Comet was the first jet to operate a transatlantic service, it was soon followed by the 707 (flown by Pan Am), with flights between New York and Paris.

PAN AMERICAN
N710PA
PAN AM
707

COMET

Boeing 747

The 747 was developed by Boeing but its expensive $2 billion development costs could only be borne thanks to a $500,000,000 advance order for 25 of the new jets by Pan Am. It proved to be a winning idea. The design was not revolutionary, but it was a very daring decision to build such a giant machine (over 70-metres- [230-feet-] long with a wingspan of nearly 60 metres [195 feet]) at a time when many felt that supersonic travel would be the next "big thing". It also meant that many airports had to be extensively modified to cope with its size. Since it first flew in 1969, the 747 has served with airlines all over the world. It has been adapted to carry freight as well as passengers, and it is one of the most recognizable aircraft ever built.

The Boeing 747, being displayed to the public for the first time took place at Everett, Washington on September 30.1968

BOEING
747
KLM
BOAC
TWA

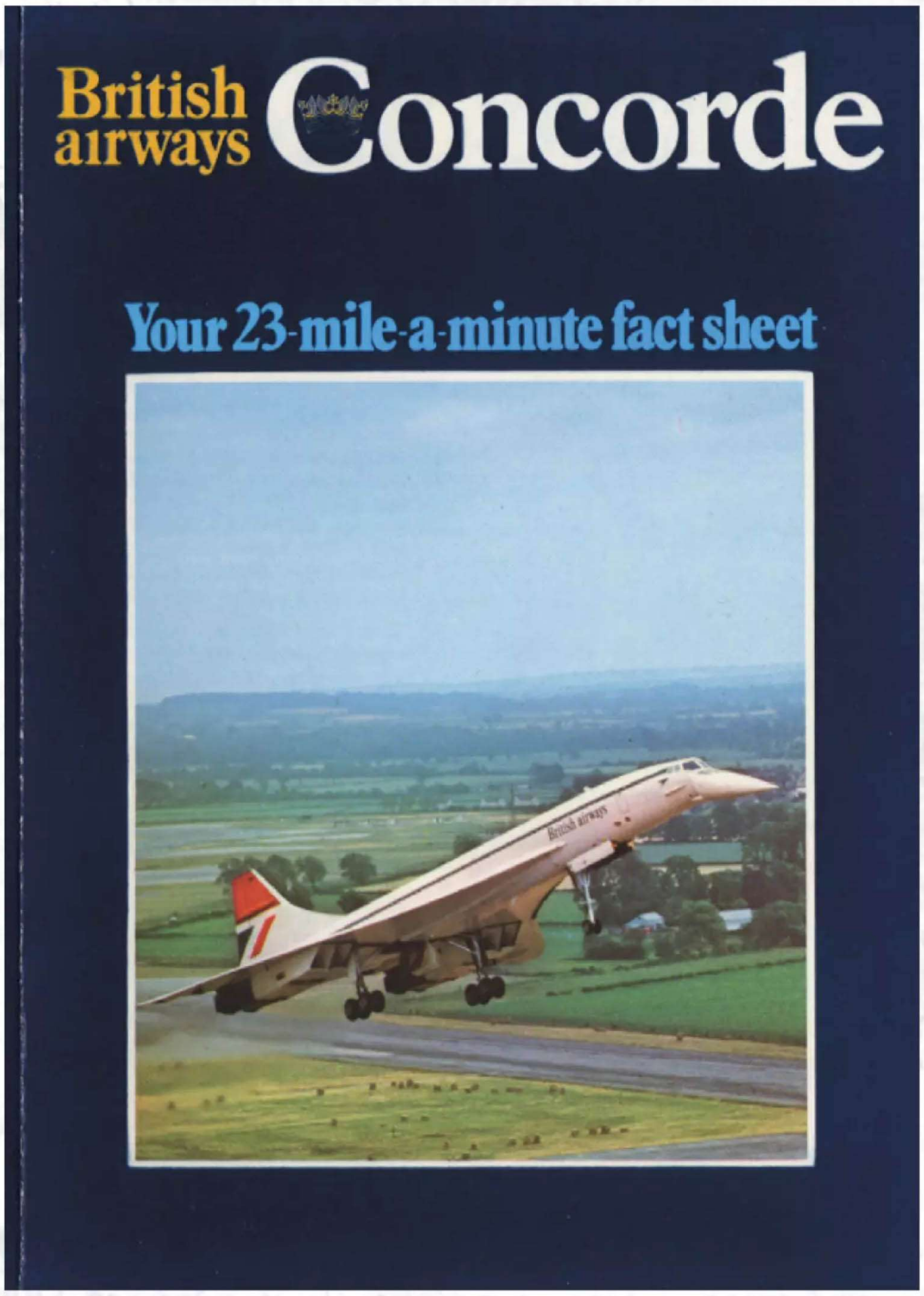
During the 1960s, Boeing developed the 727 and 737, which both proved popular with airlines. Other manufacturers created some notable designs, such as the Douglas DC-9 and the British Aircraft Corporation One-Eleven. A new aura of glamour surrounded these comfortable jets, profoundly of its time and firmly a part of 60s popular culture, and a new term – "the jet set" – was coined to describe the flyers who enjoyed the globe trotting lifestyle. Passenger numbers began to increase, especially in the United Kingdom, thanks to the continued expansion of "package tours", when single tour operators sold whole holidays, including air travel and accommodation, at discounted prices.

The obvious next step for passenger travel was increased speed, specifically the breaking of the sound barrier. In the US, Boeing began developing the 2707. In the Soviet Union, Tupolev designed the Tu-144. But only one supersonic design made it from drawing board to successful airline service; the Anglo-French BAC/Aérospatiale Concorde, which first flew in 1969 – around a decade after all of the programmes began. It proved very difficult to get clearance to operate what was felt by some to be an extremely noisy, fuel hungry, ecologically unsound aircraft – especially in the United States, and the only way to offset the enormous development and operating costs was to charge astronomical prices for tickets, meaning that few could afford the luxury. Concorde proved to be too expensive for most passengers' pockets and, although it was very popular with the minority who could afford the experience, it was only ever operated by two airlines.

The future turned out not to belong to the fastest, but to the biggest. At the same time as Concorde was being designed and built, Boeing developed the now-iconic\ 747 (popularly known as the "Jumbo"), able to carry over 400 passengers. Nothing as big had been built before; at the time fewer than 200 passengers was the norm. The 747 was followed by the McDonnell Douglas DC-10 and the Lockheed TriStar. However, the difficult world economic conditions meant that the airline industry found it hard to prosper in the 1970s, despite the introduction of these so-called "wide bodies".

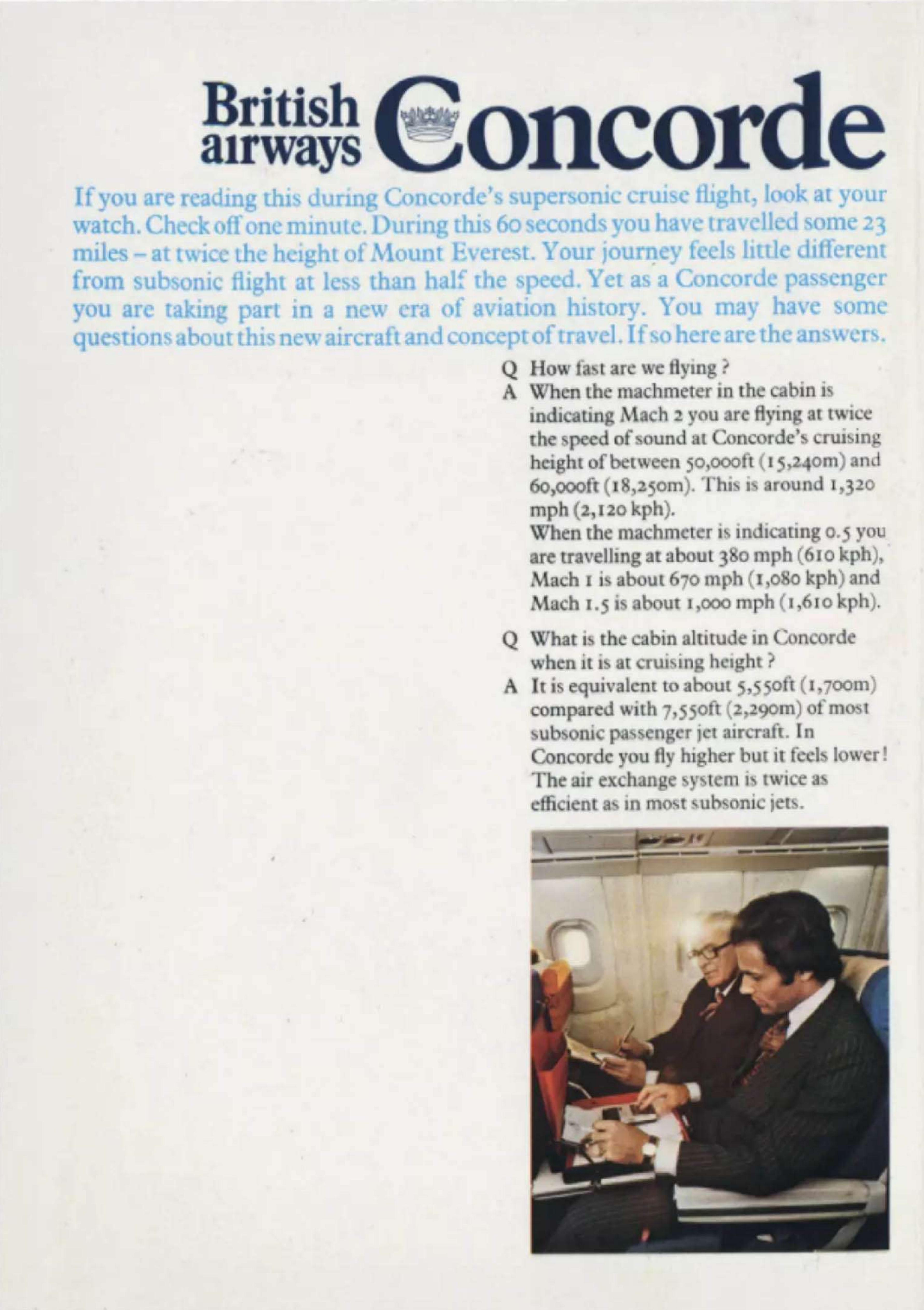
But prices steadily improved for passengers. Increasing competition was one important reason, thanks to the US government's opening up of routes in America to smaller competitor airlines, and the rise of charter operators in Europe was another. Some of the old established airlines suffered mortal damage, and in the 1980s and 1990s names such as Braniff and Pan Am disappeared.

In the 1980s and 1990s passenger aeroplanes continued to be refined and



British airways Concorde

Your 23-mile-a-minute fact sheet



British airways Concorde

If you are reading this during Concorde's supersonic cruise flight, look at your watch. Check off one minute. During this 60 seconds you have travelled some 23 miles – at twice the height of Mount Everest. Your journey feels little different from subsonic flight at less than half the speed. Yet as a Concorde passenger you are taking part in a new era of aviation history. You may have some questions about this new aircraft and concept of travel. If so here are the answers.

Q How fast are we flying ?

A When the machmeter in the cabin is indicating Mach 2 you are flying at twice the speed of sound at Concorde's cruising height of between 50,000ft (15,240m) and 60,000ft (18,250m). This is around 1,320 mph (2,120 kph).
When the machmeter is indicating 0.5 you are travelling at about 380 mph (610 kph), Mach 1 is about 670 mph (1,080 kph) and Mach 1.5 is about 1,000 mph (1,610 kph).

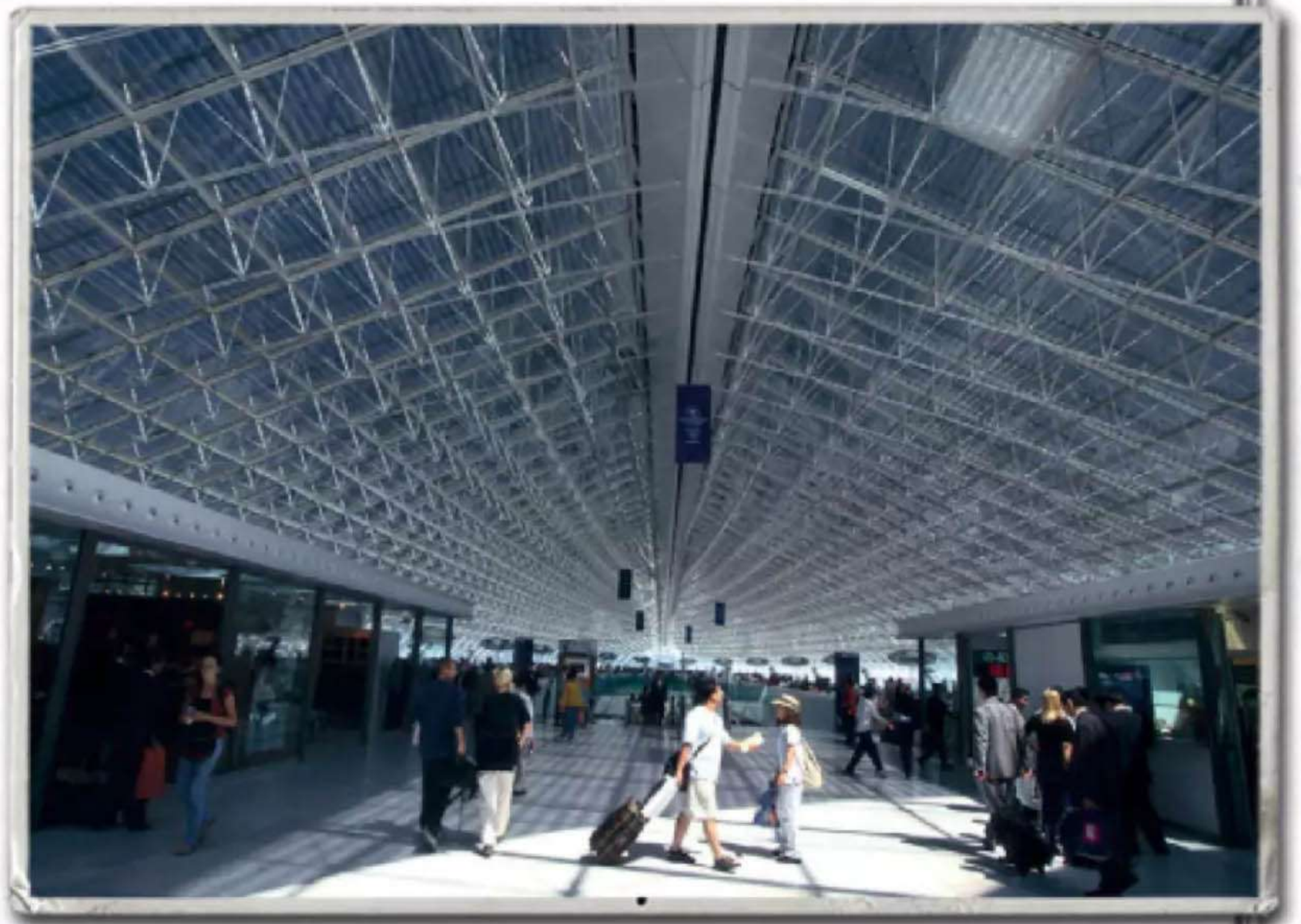
Q What is the cabin altitude in Concorde when it is at cruising height ?

A It is equivalent to about 5,550ft (1,700m) compared with 7,550ft (2,290m) of most subsonic passenger jet aircraft. In Concorde you fly higher but it feels lower! The air exchange system is twice as efficient as in most subsonic jets.

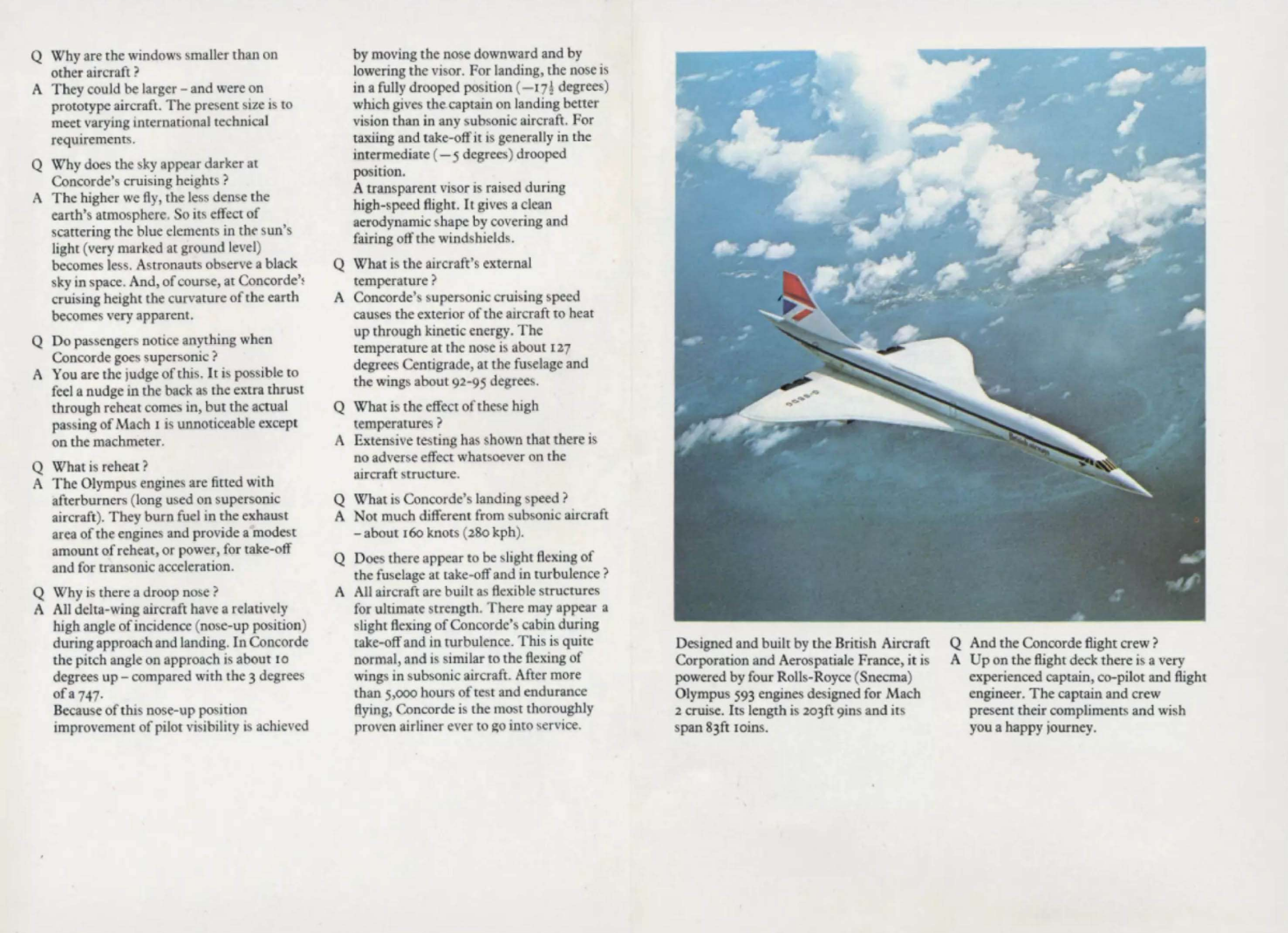
improved by manufacturers, but there were no great "quantum leaps". New systems such as fly-by-wire control were introduced in some airliners – the Airbus A-320, for example – but the basic shapes and speeds of transport fleets remained fairly constant. By the 1990s and early 2000s, there were more passengers flying than ever before, but the experience of flying had become for most people akin to train or bus services: useful to their lives in terms of business or holiday travel, but certainly not offering the pulse-quickening glamour of five decades ago.

Charles De Gaulle Airport

A modern airport is a giant transport interchange with hundreds of thousands of people arriving by car, train or bus and departing by aircraft (or vice versa). The largest of these have the same services as a small town, employing thousands of people handling baggage, maintaining security, selling goods, checking passports and carrying out the millions of other duties needed to keep the world on the move. Opened in 1974, Charles de Gaulle in Paris is an archetypal giant international airport and its futuristic design was created specifically for the "jet age". Now, in Europe, only London Heathrow handles more passengers per year.



BELOW: The British Airways Concorde fact sheet provided by the airline to passengers on the legendary supersonic airliner. Concorde was the only successful supersonic passenger aircraft. It was operated by both British Airways and Air France.



Q Why are the windows smaller than on other aircraft ?
A They could be larger – and were on prototype aircraft. The present size is to meet varying international technical requirements.

Q Why does the sky appear darker at Concorde's cruising heights ?
A The higher we fly, the less dense the earth's atmosphere. So its effect of scattering the blue elements in the sun's light (very marked at ground level) becomes less. Astronauts observe a black sky in space. And, of course, at Concorde's cruising height the curvature of the earth becomes very apparent.

Q Do passengers notice anything when Concorde goes supersonic ?
A You are the judge of this. It is possible to feel a nudge in the back as the extra thrust through reheat comes in, but the actual passing of Mach 1 is unnoticeable except on the machmeter.

Q What is reheat ?
A The Olympus engines are fitted with afterburners (long used on supersonic aircraft). They burn fuel in the exhaust area of the engines and provide a modest amount of reheat, or power, for take-off and for transonic acceleration.

Q Why is there a droop nose ?
A All delta-wing aircraft have a relatively high angle of incidence (nose-up position) during approach and landing. In Concorde the pitch angle on approach is about 10 degrees up – compared with the 3 degrees of a 747.
Because of this nose-up position improvement of pilot visibility is achieved by moving the nose downward and by lowering the visor. For landing, the nose is in a fully drooped position (—17½ degrees) which gives the captain on landing better vision than in any subsonic aircraft. For taxiing and take-off it is generally in the intermediate (—5 degrees) drooped position.
A transparent visor is raised during high-speed flight. It gives a clean aerodynamic shape by covering and fairing off the windshields.

Q What is the aircraft's external temperature ?
A Concorde's supersonic cruising speed causes the exterior of the aircraft to heat up through kinetic energy. The temperature at the nose is about 127 degrees Centigrade, at the fuselage and the wings about 92-95 degrees.

Q What is the effect of these high temperatures ?
A Extensive testing has shown that there is no adverse effect whatsoever on the aircraft structure.

Q What is Concorde's landing speed ?
A Not much different from subsonic aircraft – about 160 knots (280 kph).

Q Does there appear to be slight flexing of the fuselage at take-off and in turbulence ?
A All aircraft are built as flexible structures for ultimate strength. There may appear a slight flexing of Concorde's cabin during take-off and in turbulence. This is quite normal, and is similar to the flexing of wings in subsonic aircraft. After more than 5,000 hours of test and endurance flying, Concorde is the most thoroughly proven airliner ever to go into service.

Designed and built by the British Aircraft Corporation and Aerospatiale France, it is powered by four Rolls-Royce (Snecma) Olympus 593 engines designed for Mach 2 cruise. Its length is 203ft 9ins and its span 83ft 10ins.

Q And the Concorde flight crew ?
A Up on the flight deck there is a very experienced captain, co-pilot and flight engineer. The captain and crew present their compliments and wish you a happy journey.

MODERN AIR POWER

Technological advances made air power even more effective in the late twentieth and early twenty-first centuries. But the huge cost of this technology has meant that the gulf between the air forces of the richest nations and those of the poor has grown enormously. With many of the conflicts in the last 30 years taking place between countries of vastly differing levels of military technology — so-called asymmetrical warfare — it is no surprise that often the results can be overwhelmingly one-sided.

The archetypal modern combat aircraft is expensive, packed with computer equipment and armed with weapons that are themselves more costly than ever before. Arguably the first of this generation of supermachines were the US Navy's F-14 Tomcat and USAF F-15 Eagle, both of which were introduced in the mid-1970s. They were more powerful and vastly more advanced in terms of their computer and flight-control systems than anything that had gone before.

A consequence of increasing aircraft cost was the move towards multi-role combat aircraft. Building dedicated fighters, bombers and reconnaissance aircraft was not an option for many governments, hence the development of aircraft such as the Panavia Tornado in the 1970s. Not only was the Tornado designed to carry out the major strike and air defence roles, but its construction was only made possible thanks to international co-operation.

The 1982 Falklands War did not involve the very latest hi-tech combat aircraft, but it did feature the Vertical/Short Take-Off and Landing (V/STOL) Harrier, an ingenious 1960s design that managed to comprehensively defeat Argentina's air force by providing valuable air

RIGHT: A Northrop Grumman KC-30 tanker refuels a B-2 Spirit in mid-air during a test flight. Stealth aircraft are very difficult to detect owing to their unusual, angular shape and to the material that covers them. Just as important to modern air forces are the air-to-air refuelling tankers that can keep combat aircraft in the air for many hours, dramatically increasing their range.

Apache AH-64

The Apache is generally regarded as the ultimate ground-support weapon. The first AH-64 entered US Army service in 1984, and around 1,500 have been delivered to date. Nine nations operate, or have selected, the latest variant, the AH-64D, including the UK, Japan and the Netherlands. It is equipped with Hellfire missiles and a 30-millimetre (1.2-inch) automatic cannon, and the crew is assisted in locating targets by laser and infrared systems. The Apache can cruise at up to 284 kilometres per hour (176 miles per hour). Often responding to calls for assistance from troops on the ground, this helicopter has proved extremely effective in modern conflicts such as Afghanistan and Iraq.

A McDonnell Douglas F-15E Strike Eagle. The F-15E is a multi-role aircraft able to undertake both air-to-ground and air-to-air combat missions. It can carry a variety of different weapons, and variants of the F-15 have been in service with the USAF since the mid-1970s.

ED

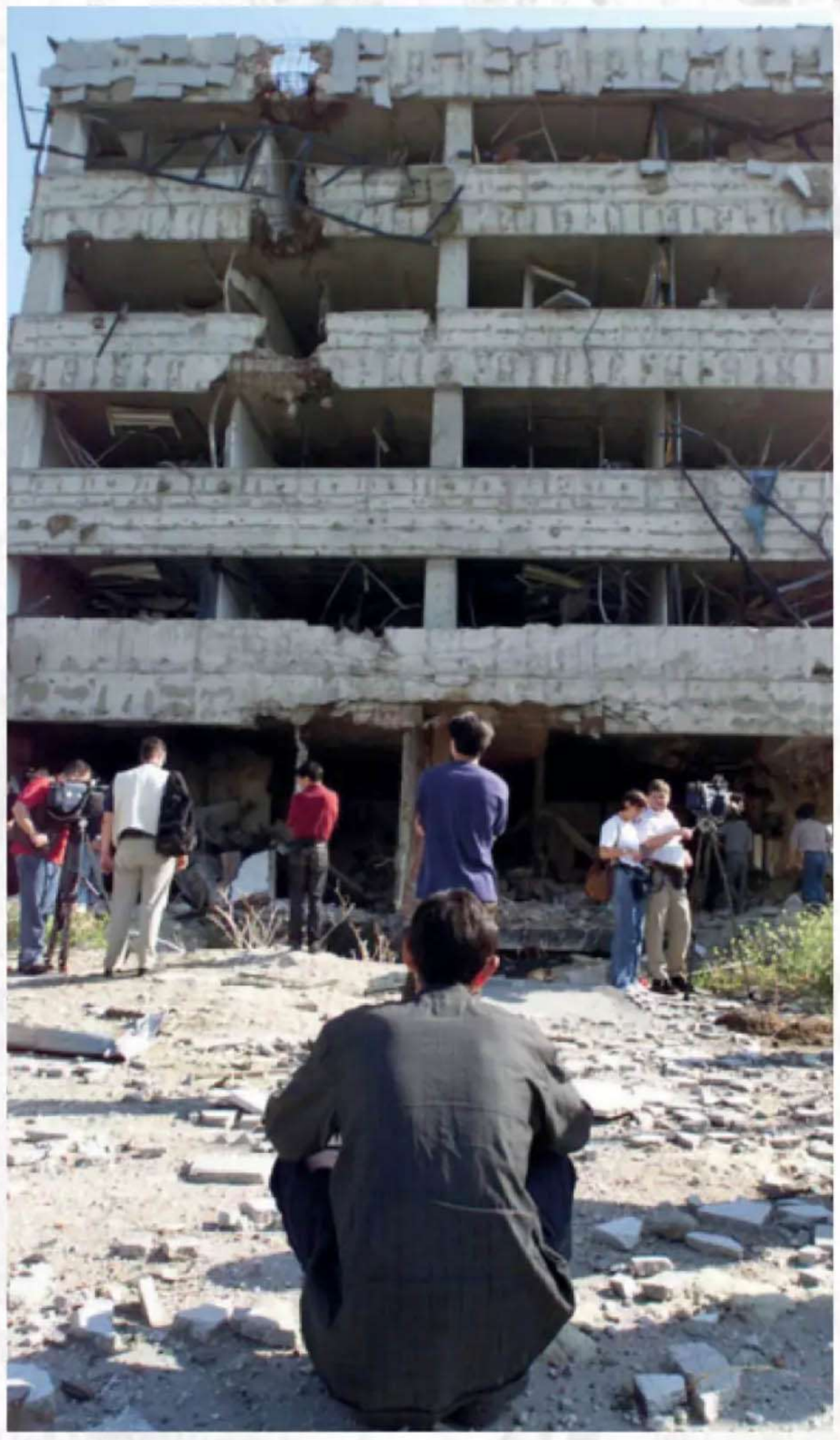
AMC
POPE
40499
USAF
U.S. AIR FORCE

cover for the British task force sent to reclaim the islands.

The 1991 Gulf War showed just how effective the most advanced aircraft and weapons can be. Some argued that the US-led coalition's demolition of the Iraqi army's ability to wage war demonstrated that air power could win a war alone – although it was still necessary to send in ground troops to liberate Kuwait. But it was not just the precision "smart bomb" strikes on command and control centres by stealth aircraft such as the F-117, or the destruction of enemy tanks by A-10 Warthogs, nor the direction provided by Airborne Warning and Control (AWACS) aircraft that contributed to victory. Once again, the humble transport aircraft came into its own. C-130s moved coalition forces into and around Saudi Arabia, and in one notable operation, supported the movement of some 250,000 troops into new positions prior to a major attack.

The remarkably low number of coalition casualties in the Gulf War (especially when compared with Iraqi casualties) added hugely to the perception that air power was a distinctly low-risk method of projecting strength. For example, it was perceived to be more politically expedient (particularly in the United States) to use air strikes to oust Serbia from Kosovo in 1999. Putting troops on the ground would have been extremely unpopular back home. The campaign succeeded in its principle objective with no US or NATO casualties. Today, Unmanned Aerial Vehicles used for a variety of reconnaissance and strike roles reduce the risk of military casualties even further.

The 11 September 2001 terrorist attacks on New York and Washington and the subsequent "War on Terror" led to highly advanced aircraft being used in another "asymmetrical" conflict. Although initial phases of the war against the Taliban in Afghanistan again showed the value of aircraft in modern war, the continued presence of American, British and other coalition troops in that country has demonstrated that a determined and fanatical guerilla force can still prevent technological superpowers from achieving ultimate victory. The lessons were similar in Iraq in 2003. Despite the spectacular "shock and awe" attacks that began the campaign and quick victory in the conventional regime change phase of the war, only a "surge" of troops on the ground eventually began to turn the tide against the insurgents.



ABOVE: The Chinese embassy in Belgrade, Yugoslavia (now in Serbia) a year after it was bombed in error by US aircraft in May 1999. NATO blamed the attack on inaccurate targeting information, proving that despite the development of accurate "smart bombs", mistakes that result in the death of innocent civilians can occur, either through systems malfunction or, as in this case, human error.

LEFT: U.S. Air Force C-130 cargo plane, Lockheed C-130 Hercules. Capable of using unprepared runways for takeoffs and landings, the C-130 was originally designed as a troop, medical evacuation, and cargo transport aircraft.

Lockheed C-130 Hercules

The C-130 Hercules is the ultimate transport workhorse. Since entering service with the USAF in 1956, variants have served with the air forces of 50 nations. It is an extremely robust aircraft, and can take off from short and unprepared runways. But the most important reason for its longevity is the enormous flexibility of the design. Its main duties are troop and military cargo transport, but in its career the Hercules has also been used as a gunship, a refuelling tanker, a search and rescue platform, and as a humanitarian aid aircraft. It is a key component of any modern army and is set to remain in service for many years to come.

AVIATION FOR ALL?

The very first aircraft were built neither for war nor for commercial transport. Aviation pioneers were driven to fly by pure curiosity. They persevered because of the novelty and thrill of taking to the air in a machine. Although warfare and transport prompted the biggest advances in aircraft technology, the private flyer — the person who flies for fun, or for personal transport, or to break records — has continued to play a key role in the continuing story of aviation.

64
THE WINNER OF
SCHNEIDER
G-AXZO

Membership of flying clubs grew in the 1920s and 1930s, notably in the United Kingdom. Privately owned aircraft, particularly the de Havilland Moth series, proved extremely popular. Companies such as Beech and Cessna began to create light aircraft specifically for the private individual in the decade immediately preceding the Second World War. In the 1950s, the market for light aircraft grew once again and it was in 1955 that the most successful light aircraft ever produced, the Cessna 172, first flew. The third major manufacturer of this type of machine, Piper, also proved that there was a huge desire for light aircraft – either used for personal transport or as real leisure craft. Bridging the gap between the small light aircraft and a large commercial airliner is the personal business jet. This most luxurious of executive accessories has, since the 1960s, come to be universally associated with individual wealth or corporate power.

However, the dream of true "aviation for all" has remained out of reach. At the most fanciful end of the spectrum, the idea of a flying car has continued to appeal, but one has yet to materialize as a viable vehicle. Kit aeroplanes were seen as a more realistic

BELOW: A Cessna 180. Cessna is one of the most familiar names in general aviation. Since the late 1920s, the company has produced a series of leisure and light transport aircraft including the Cessna 172, one of the most popular light aircraft ever built.

way to open up powered flight to the masses. Possibly the first of such machines were Henri Mignet's 1930s "Flying Fleas". Although initially popular, they were banned as unsafe by both the British and French governments. "Kit planes" similar to the Fleas have flown since and continue to fly today, but they are subject to very stringent regulations.

Light aircraft have to follow many of the same rules as military or commercial aircraft and this has served to remove much of the spontaneity from flight. Perhaps the closest to a reasonably cheap and available mode of leisure flight is the glider. Gliding offers a much less expensive way to experience the thrill of flight; and one that is less restricted by the rules that regulate light aircraft. The popularity of hot air balloons, hang-gliders, gliders, microlights, powered parachutes and sky diving demonstrates that even in the age of mass travel, the appeal of flight simply for its own sake is still very strong.

The extremely high cost of modern hi-tech aircraft makes it beyond the means of most private citizens to set some of the historically more prestigious records. "Blue riband" feats are invariably left to those with government backing. For example, the current absolute world speed record belongs to the USAF crew of a Lockheed SR-71 Blackbird. But the pioneer spirit of the early aeronauts lives on in today's record-breaking aviators. They have found other ways to push the boundaries, particularly setting distance and endurance records. Notable modern adventurers include Dick Rutan and Jeana Yeager, who flew round the world non-stop in 1986, and record-setting balloonist Per Lindstrand. These modern feats often capture the public imagination – perhaps because it is the person, rather than the machine, that is placed at the centre of the achievement.

OPPOSITE: Hot air balloons soar at the Albuquerque International Balloon Fiesta, New Mexico, USA in 2008. Balloon festivals are popular all over the world, with ever more outlandish designs being constructed.

Bombardier Learjet

The classic epitome of executive transport is, unarguably, the Learjet. Developed by William Lear in the 1960s from a fighter-bomber design, the Learjet excelled in terms of performance. It was faster than earlier private aircraft and could operate at higher altitude than many airliners. The first variant, the Learjet 23, flew from Los Angeles to New York and back in just over 11-and-a-half hours and later models set many other impressive speed and performance records. Although other manufacturers – such as Dassault in the 1970s and Gulfstream in the 1990s – created very successful executive models, the Learjet has maintained its position thanks to its continually developed and improved design.

BELOW: Dick Rutan and Jeana Yeager with their record-breaking round-the-world-aircraft Voyager in December 1985. Dick Rutan's brother, Burt, designed Voyager and went on to be responsible for several other truly remarkable machines, including SpaceShip One, the first privately developed spacecraft to successfully reach space.

Steve Fossett
PILOT

Steve Fossett
(1944–2007)

Born in Tennessee, Fossett made his fortune in stockbroking. He ploughed much of his wealth into the pursuit of records and set over 100, some on land, some at sea and many in the air. In 2005, he made the first solo non-stop round-the-world flight, and in 2006 he set the record for the longest flight (almost 77 hours, covering over 40,000 kilometres [25,000 miles]). Most famously, in 2002, he became the first man to complete a solo circumnavigation of the globe in a balloon. Fossett's achievements were recognized in 2007 when he was inducted into the American National Aviation Hall of Fame.

Hang-gliding over Yosemite Valley. Hang-gliding is possibly the closest we can get today to experiencing the true freedom of flight.

AVIATION AND THE MODERN WORLD

At the beginning of the twentieth century, many bold claims were made about the effect aviation might have on our lives. Some said it would make warfare obsolete; surely no nation would be so foolish as to go to war when its own cities and people would be so vulnerable to retaliatory attack? Others predicted that it would bring the peoples of the world together. More pessimistic prognosticators, perhaps influenced by the H G Wells classic novel The War in the Air, believed that aircraft as ultimate weapons could spell the end of civilization. In truth, aviation has been a mixed blessing, helping some and bringing harm to others.

At the start of the twenty-first century, it is important to remember just how large an industry aviation is. It employs hundreds of thousands of people worldwide, building, servicing, flying, and supporting aircraft. The craft themselves are so expensive to produce that, more often than not, international co-operation is the only viable way to build them. Even the United States makes use of international contractors to supply systems for state-of-the-art aircraft. One consolation of this massive expenditure is the increased length of operational service. Aircraft built in the first half of the twentieth century were often obsolete within a few years, whilst an air force or airline today can now expect to obtain decades of work from a modern technological marvel.

In parts of the developing world where problems are often substantially more challenging than those faced in the West, aircraft can have a dramatically positive impact. In areas made unreachable by conventional land-transport following crises such as war or natural disaster, aircraft can be used to deliver vital food and medical supplies.

Aviation makes vast inhospitable places habitable; aircraft of the Australian Royal Flying Doctor Service for example, can mean the difference between life and death

BELOW: Loading cargo at night, Cologne-Bonn airport Germany, 2007. Every year freight companies deliver hundreds of millions of packages to customers all around the world via both dedicated cargo aircraft and in the holds of passenger aeroplanes. Just two of the largest freight companies between them deliver around 18 million packages every day.

World
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AAY 85346 UPS/5X
AAY 8107 2 UPS/5X
ups
ups
TARE WT 480
TARE WT. 476

Airbus A-380

The Airbus A-380 is the largest commercial airliner in service today; the ultimate "economy of scale" transport, it is equipped to carry over 500 passengers. European consortium Airbus Industries produced a series of successful airliners in the 1980s and 1990s, and the A-380 was designed as a "hub and spoke" aircraft to fly between major airports. Owing to its enormous size, the A-380 can only operate at very large airports which have been upgraded to cope with its bulk and wingspan. American company Boeing has invested in a smaller design, the Boeing 787, which although only able to carry around half of the passengers of an A-380, may consequently prove to be a more flexible option as it offers the potential to operate from a greater number of airports.

A380
A380 AIRBUS
F-WWOW

NO STEP
NO STEP

An air/sea rescue helicopter assists a vessel in distress in 2006. In 2007 in the UK, RAF and Royal Navy rescue helicopters were called out over 1,750 times, assisting around 1,500 people.

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STOP AIRPORT EXPANSION
STOP AIRPORT EXPANSION
STOP AIRPORT EXPANSION

ABOVE: Airport expansion is a controversial and divisive issue. While many argue that increased capacity is necessary to satisfy the rising public demand for air travel, protests often centre on environmental concerns about the impact of more flights on climate change, and the fears of local people who are concerned about increased noise and air pollution.

ABOVE: Pakistani policemen unload supplies from a US transport helicopter in Kashmir in 2005 after a devastating earthquake. In the wake of this huge natural disaster, helicopters provided one of the best means of supplying aid to villages in the affected areas. They were also used to evacuate injured people.

Eurofighter Typhoon

in remote areas. And it is not just in the Australian bush that aircraft can play such a vital role. Modern air ambulances are able to transport critically injured patients to hospital within minutes, and the lives of numerous climbers and mariners have been saved by rescue helicopters and air-sea rescue crews.

For many of us, our involvement with flying is limited to holiday or business travel. We can also keep in regular and close contact with family and friends spread across the world, thanks to the network of air routes that criss-cross the planet. We are increasingly accustomed to the ready availability of imported products, the delivery of which is often time-dependent. The range of items that are transported by air is staggering – from fresh flowers to computer equipment, from exotic fruit to the mail.

However, it is inevitable that when so many people can fly to so many destinations, problems may result. Some locations around the world gain enormous benefit from visiting travellers, but others face unwelcome and sometimes crippling over-development thanks to unrestricted and unsustainable tourism. Perhaps most alarmingly of all, aviation is one of the fastest growing producers of the gases that cause the greenhouse effect. An overwhelming body of evidence shows that this is having a devastating impact on our planet. One of the most enduring and horrifying images of recent times was the sight of passenger aeroplanes flying into the World Trade Center in New York, and the Pentagon in Washington. Although the use of aircraft by terrorists is mercifully a rare occurrence – thanks in part to the increased levels of security at most modern airports – there is another equally sobering aspect of their existence: they make national and even natural borders unimportant. While this is a tremendous boon for travellers, it can be a terrifying prospect for the civilians who, since the First World War, have been placed in the front line of battle, thanks to the awesome power of aerial bombardment.

ABOVE AND RIGHT: The 11 September 2001 attacks on the World Trade Center in New York, USA. Nearly 3,000 people died when terrorists crashed four hijacked airliners into the World Trade Center, the Pentagon in Washington and a field in Pennsylvania.

Eurofighter Typhoon

The Eurofighter Typhoon in many ways symbolizes the modern aircraft industry. Although it was originally designed during the Cold War, because of an extremely lengthy development process, it did not enter service until over a decade after the fall of the Berlin Wall in 1989 and the end of communism in the Soviet Union. The product of four countries working in collaboration (Britain, Germany, Italy and Spain), Eurofighter parts are built all over Europe, with final assembly taking place in every one of the partner nations. The design has by necessity changed and evolved, so that what was once intended as a pure fighter now fulfils many other combat roles, including bombing and reconnaissance.

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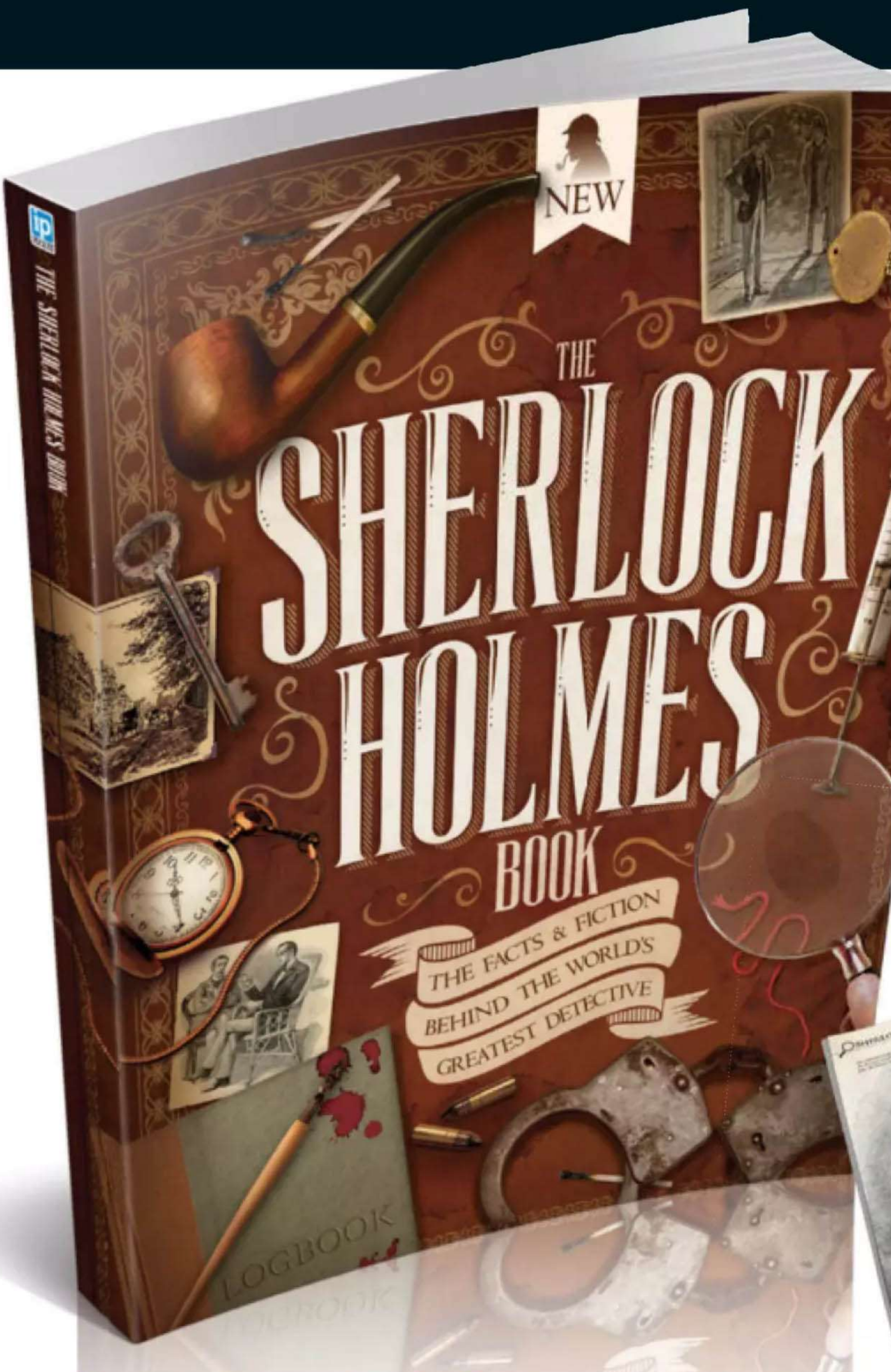
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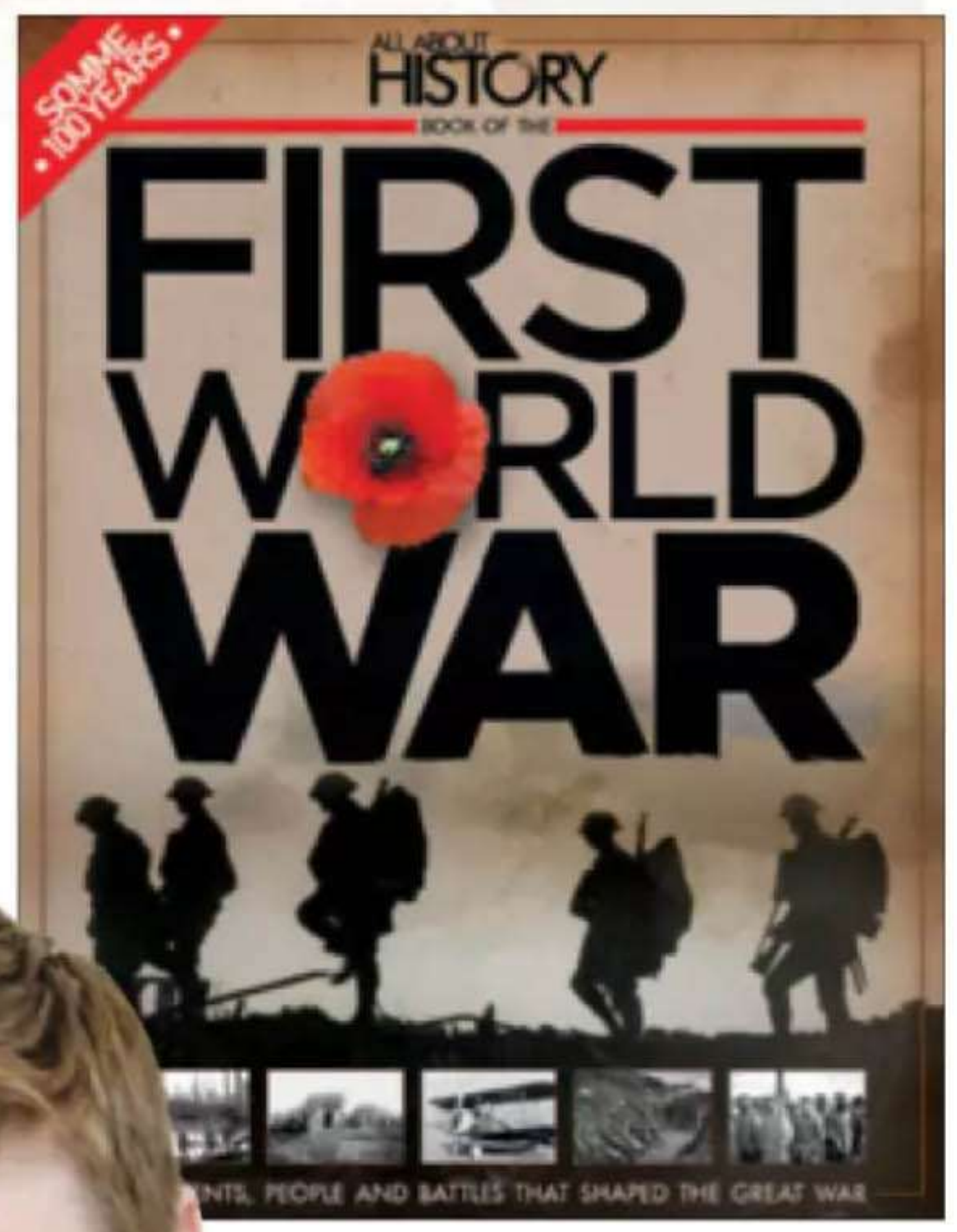
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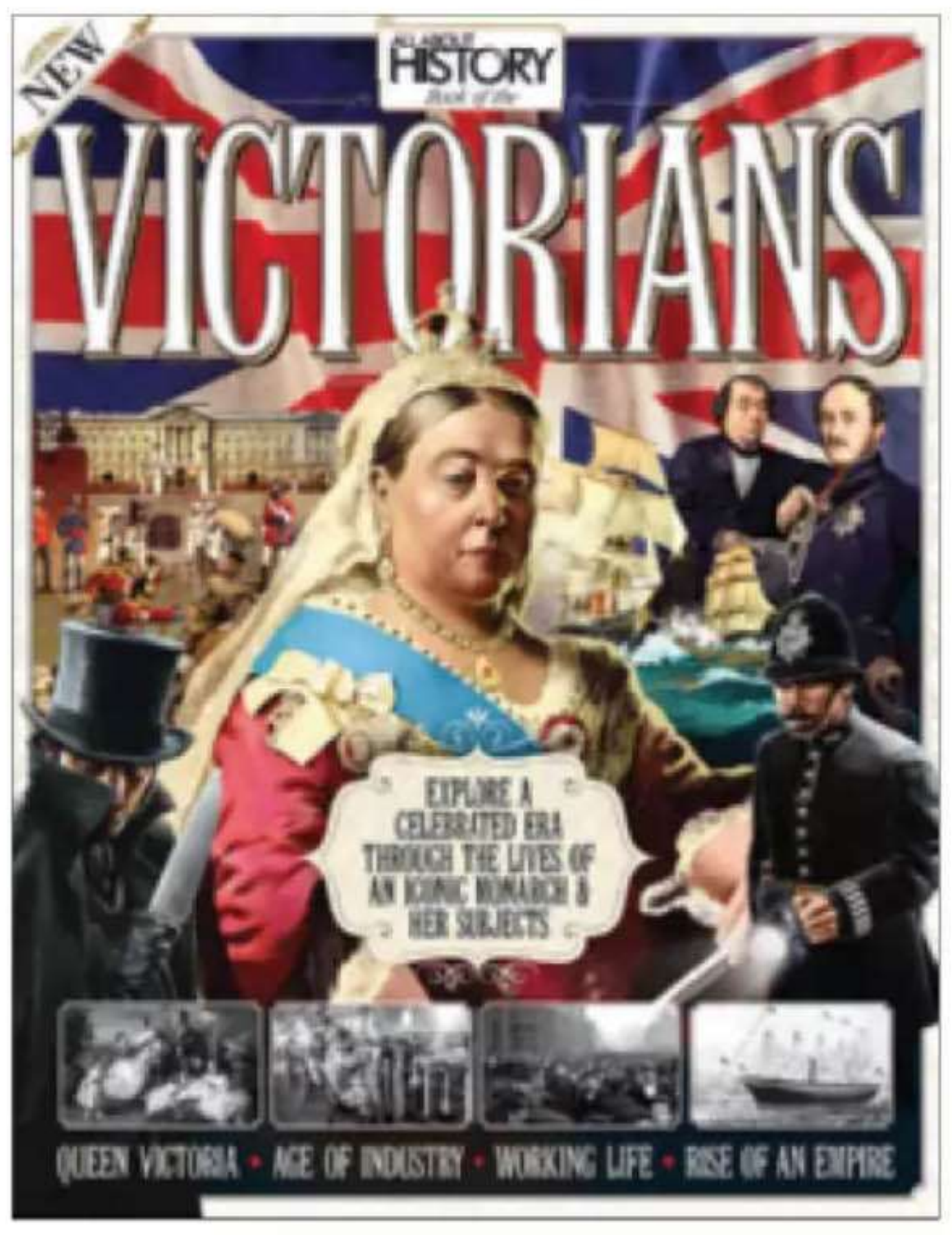
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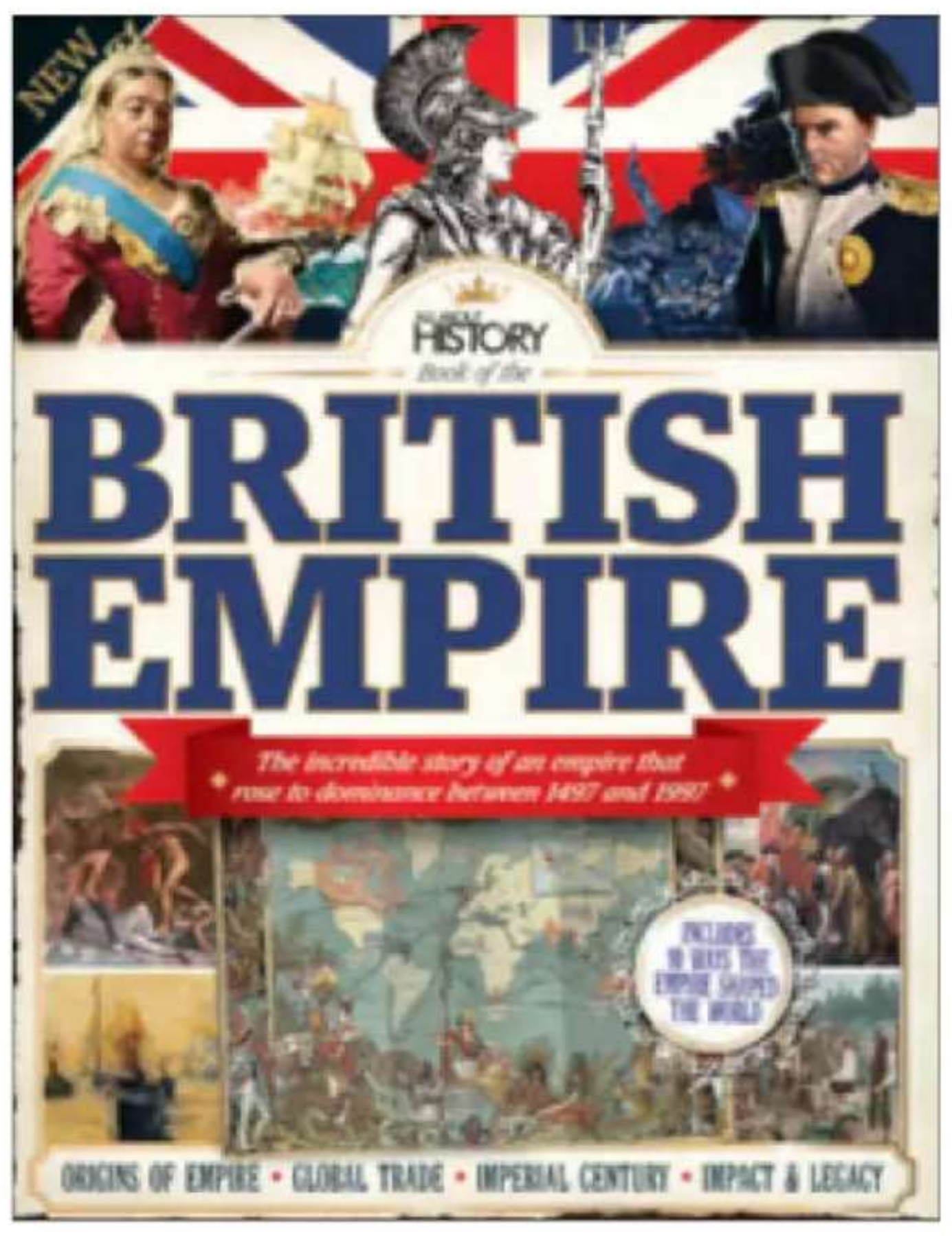
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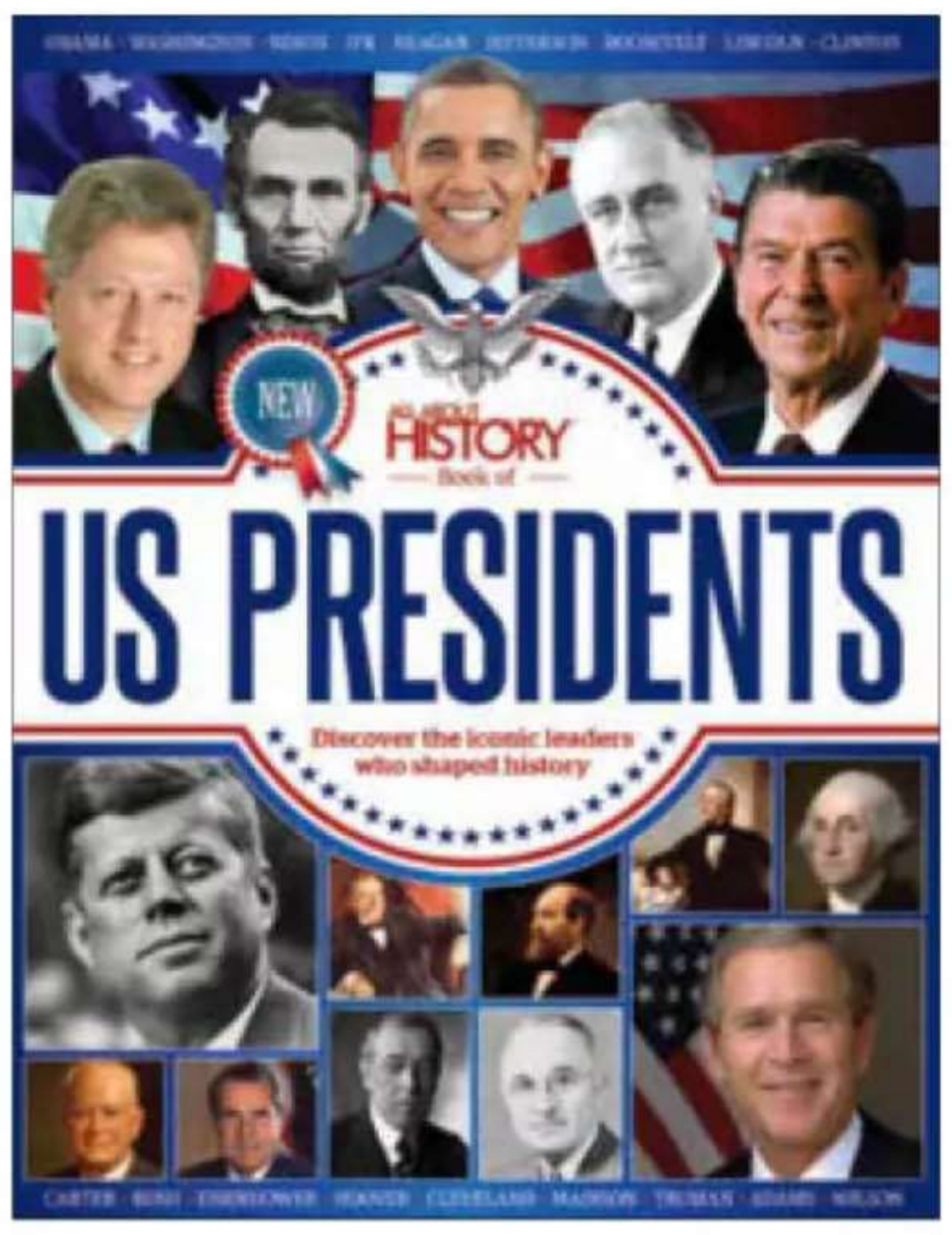
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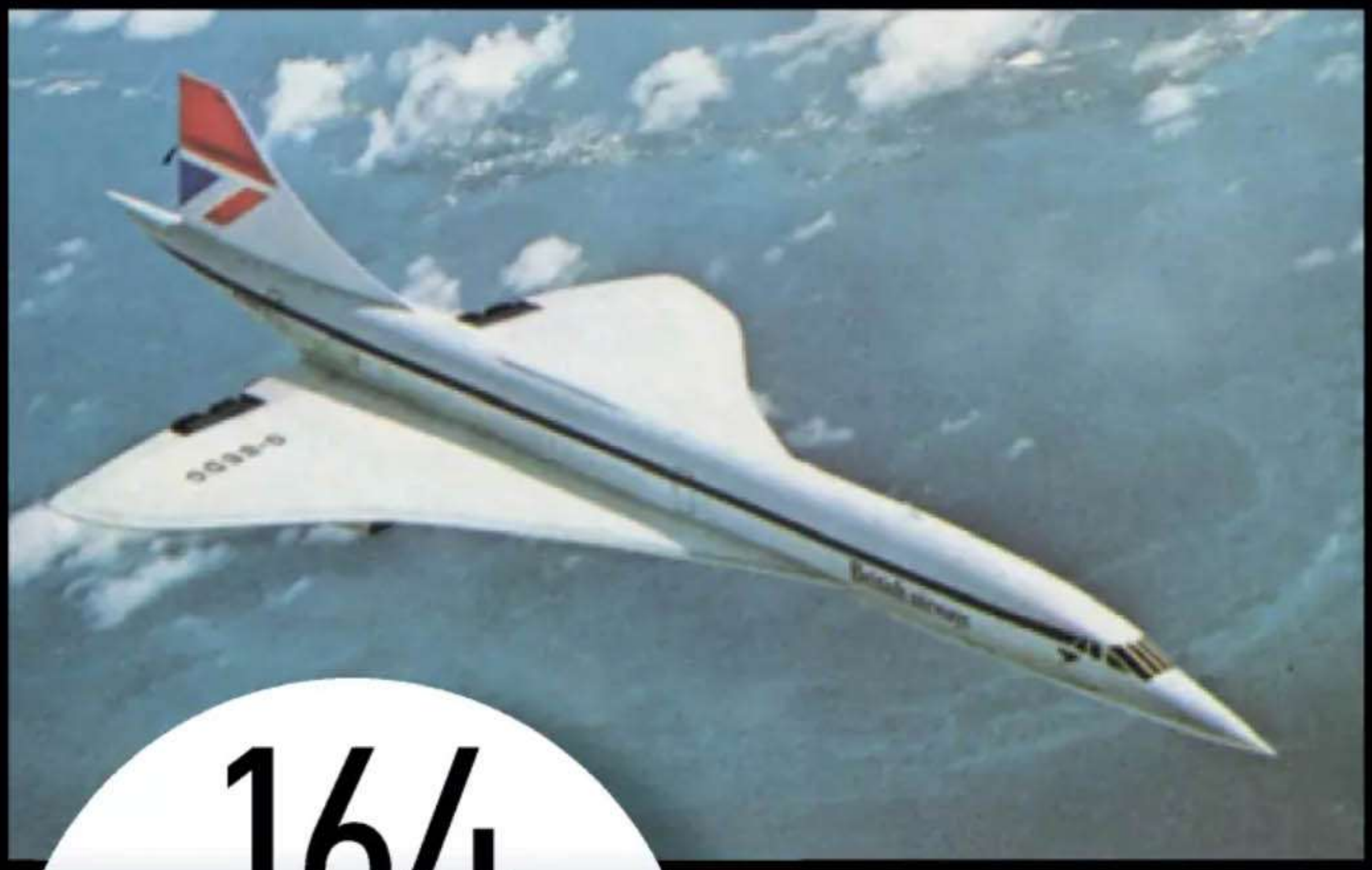

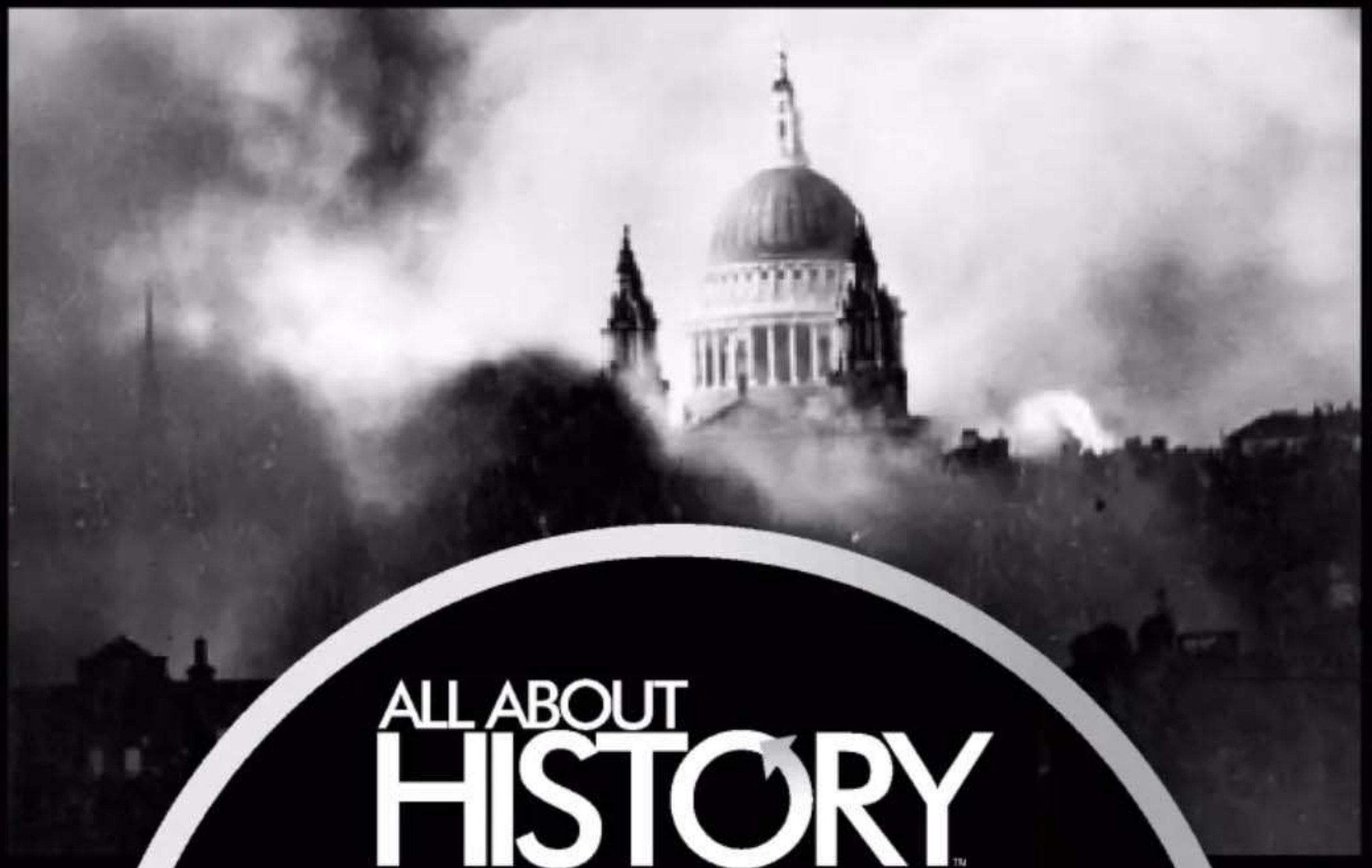

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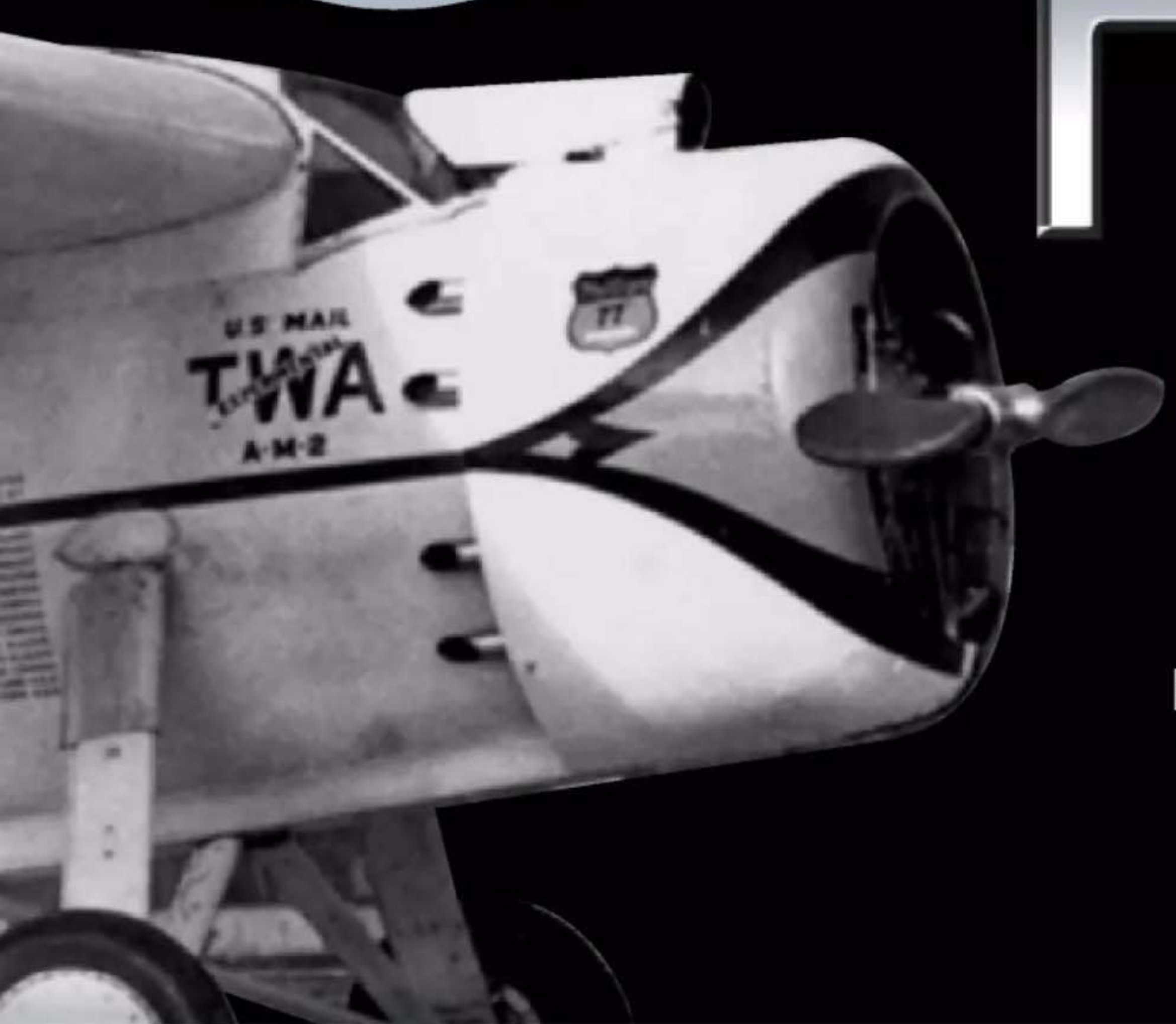
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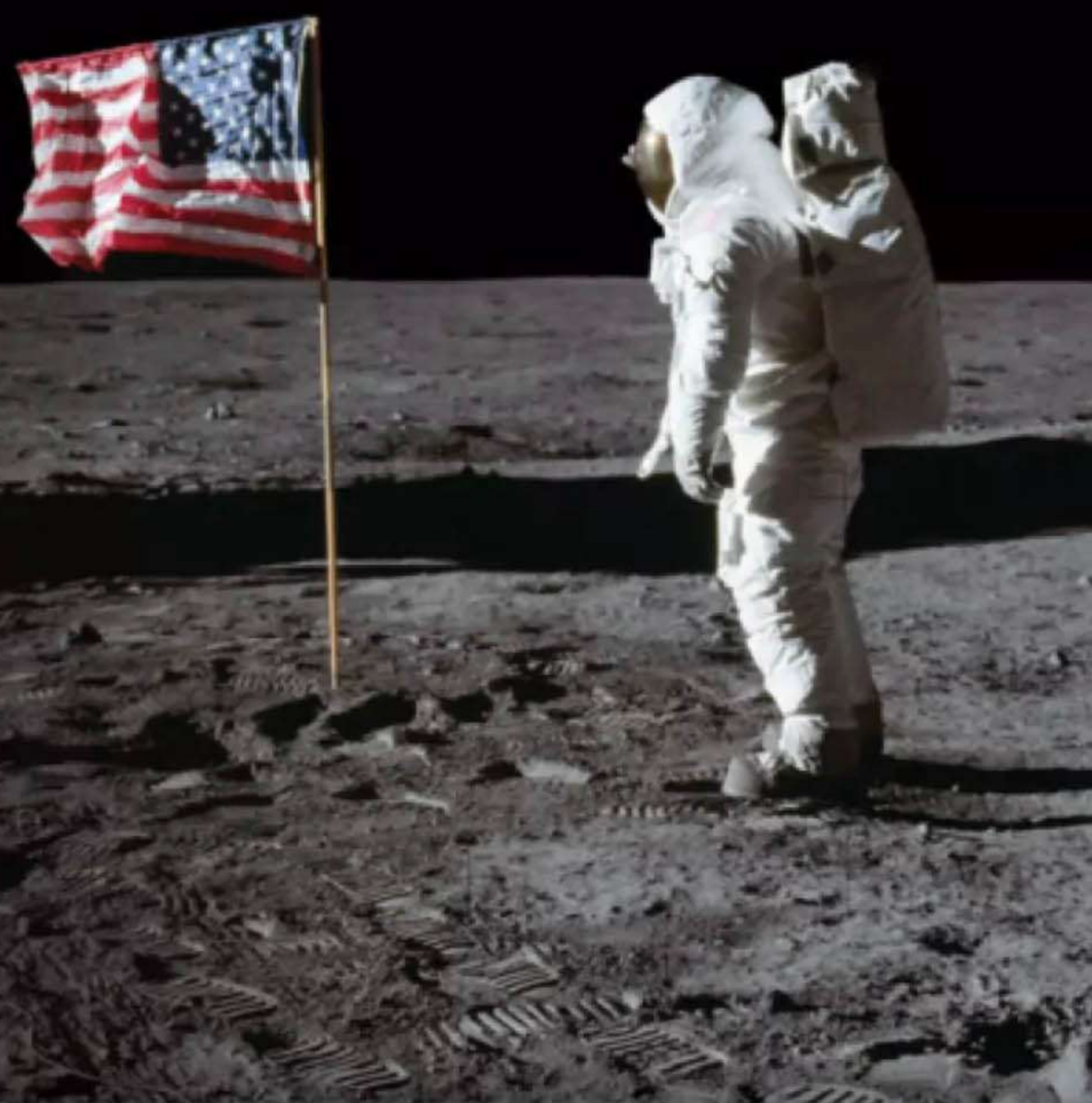

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